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## Using hypermedia to improve the dissemination and accessibility of syllabus documents with particular reference to primary mathematics

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**Using hypermedia to improve  
the dissemination and accessibility  
of syllabus documents  
with particular reference to  
primary mathematics.**

by

**Alistair Campbell**

**B App Sc, Dip Ed, Post-Grad Dip Ed (Maths)**

**A thesis submitted in  
partial fulfilment of the requirements for the Award of**

**Master of Education.**

**at the Faculty of Education, Edith Cowan University**

**Date of submission: 15/12/93**

## Abstract

The fundamental question that this study set out to investigate was: Can the advantages of hypermedia be extended to curriculum materials that are for the sole use of teachers? To consider this question, three areas needed to be investigated: hypermedia (the medium); teachers (the target) and curriculum documents (the content).

Hypermedia has a long history dating back to Bush (1986) who in 1945 imagined his Memex system as building information trails between ideas. However, it was not until the mid 1980s that technology caught up with the theory and hypermedia came of age. The evaluation of hypermedia documents is still in its infancy and design standards are still being formulated. Social acceptability and usability will be of major concern in the evaluation process of hypermedia. Therefore this study needed to investigate whether this medium of presentation is socially acceptable to teachers?

Advances in Information Technology (IT), both in hardware and software in the last few years have brought the potential of hypermedia to the personal computer (PC). Information, be it text, sound, graphics or video, or a mixture of these, can now be presented on the same screen and the movement between screens can be seamless. The movement between screens is no longer limited to sequential movement as it is when the information is presented in a hard copy form, but can be randomly accessed. This access allows the user to move about the information as they would move about within their own minds, that is, by association. Already commercial hypermedia products are being produced for the education and "leisure" markets.

Teachers' work loads are increasing, as they take on more curriculum responsibilities, while at the same time, information is expanding at a rapid rate. The challenge today is to encourage teachers to use new information technology to overcome these problems.

However, since their inception into schools fifteen years ago, computers have not delivered the results that had been expected of them. Can the access to hypermedia curriculum documents help teachers to lessen their work load and encourage them to use IT?

Firstly, it is important to consider whether curriculum materials for teacher use are suitable for hypermedia presentation. The literature indicated that textual materials that are not meant to be read sequentially like a novel, are suitable to be presented in hypermedia form. At present, curriculum materials for teachers contain the content in hard copy form but the presentation is lacking in quality. This hard copy material is expensive, hard to correct and slow to update. Hypermedia offers the potential to overcome these limitations and to provide easy access to much more information. This new medium could allow teachers for the first time to truly integrate their teaching programme by enabling them to access multiple curriculum documents.

The methodology used in this study was based on two types of descriptive research, survey and correlation methods. The target population for this study was all K-7 teachers using the Western Australia Mathematics syllabus within Western Australia. The instrument was a mailed survey questionnaire that consisted of five parts. The first part consisted of collecting personal data such as age and gender. The second part was the *Computer Attitude Scale* (CAS), designed by Loyd and Gressard (1984), and was used to measure attitudes towards learning and using computers. The third part consisted of questions that asked teachers for their views and impressions on the social acceptability and utility of the present hard copy. The fourth part consisted of questions on computer experience and use, both in and outside the classroom. The final part consisted questions on the likely acceptance and usefulness of a hypermedia copy of the syllabus.

This study found that the likely medium-based anxiety for this type of application is low for the teachers sampled, with 70 percent indicating that they were likely to accept this type of application. The findings indicated that the acceptance rate increased as the teachers' positive attitude towards computers increased. Teachers that rated themselves competent at using a computer were also more likely to accept this type of application. Time spent using a computer at school showed that teachers who frequently use them at least several times a week were more likely to accept this type of application. The study also found that the majority of teachers sampled considered the ability to link the syllabus to other teaching material was very useful. Many of the problems identified by the teachers sampled concerning the usability of the present hard copy could be overcome using a hypermedia version.

## Declaration

I certify that this thesis does not incorporate, without acknowledgment, any material previously submitted for a degree or diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature :

Date ..... 15<sup>th</sup> December 1993 .....

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# Chapter One

## Introduction

### The background to the study

We are in the early stages of what some have called the 'Electronic Age' or 'Information Age' where new technology based on the microprocessor (computer) is used to handle information (McLuhan and Powers, 1989). Hypermedia is an early manifestation of this developing age. Advances in computer hardware and software in recent years have taken hypermedia from the realm of theory to that of potential applications in educational settings. These educational applications have largely focused on teacher to student instruction or student use in learning, not purely for teacher use as a support tool.

Information, be it text, sound, graphics or video, or a mixture of these, can now be presented on the same screen and the movement between the screen displays is now seamless. Thus, at last using one medium, that of the computer screen, all the different media can be presented together. Further, the movement between screen displays is no longer limited to sequential movement, as it is when the information is presented in a hard copy form, but can be randomly associated. This allows users to move about the information as they would move about within their own minds, that is by association. Already commercial products are being marketed which make use of this potential.

Hypermedia has a long history dating back to Bush (1986) who in 1945 imaged his Memex system as building "information tails" between ideas. However, it was not until the mid-eighties that technology caught up with the theory and hypermedia came of

age. However, the evaluation of hypermedia documents is still in its infancy and design standards are still being formulated. Clearly considering Nielsen's model for system acceptability (Nielsen, 1990), what he calls social acceptability and usability will be of major concern in the processes of evaluation of hypermedia. Duffy, Mehlenbacher and Palmer (1989) state that "in theory, at least, presenting documentation and tutorials online has several advantages over the print medium: greater availability, easier access, more interactive, low cost / high accuracy and multimedia and AI" (p 363). It is clear that the concept of hypermedia is here to stay and it is only how it may be best applied which is being debated.

The linking of hypermedia and expert systems promises a framework for building powerful informational retrieval systems (Young, 1990). During the mid-eighties Ingwersen (1992) found that artificial intelligence (AI) became interested in information retrieval "mainly because knowledge-based building and structuring, for example in expert systems, may require retrieval technology, and because searching for information in textual form is an intriguing affair" (p 59). An example of this link is seen in the work of Barden (1989) who used Apple's HyperCard to produce an intelligent tutoring system, called 'HyperCard Intelligent Training System'.

A major trend in the administration of education in Australia since the late 1960s has been the growing decentralisation of decision-making and the involvement of more groups in this decision-making process (Marsh, 1988). This process is placing more power in the hands of schools in terms of the development of both the school and subject curriculum (Strurman, 1989). An example of this, in Western Australia, is seen in the unit curriculum for lower secondary that emerged from the Beazley Report (1984). Teachers' work loads are increasing as they take on more curriculum responsibilities and as information expands at a rapid rate. These trends are placing great demands on the dissemination of curriculum materials. This is particularly the case when considering curriculum documents that are for teacher use only. They

contain the necessary content but often the presentation is of poor quality, which prevents efficient use of the documents. Another problem is that updates and corrections to these documents are typically slow in materializing. Hypermedia offers the potential to overcome these problems of dissemination, presentation and updating.

There appears to be a need to expand the application of hypermedia technology to the delivery of information directly for teacher use. This has led me to the conceptualisation of a hypermedia, knowledge-based information management system for teachers and to the development of a proof-of-concept demonstration hypermedia document based on the Western Australia Mathematics syllabus produced by the Ministry of Education (1989). This prototype contained the syllabus materials linked to teaching resources and background information, in a form that is easy to access and update. At present the education departments within Australia disseminate syllabus documents and other teacher information only in hard copy form. The question is whether the advantages of a hypermedia form of dissemination of information be gained when the material is a syllabus?

This prototype of an interactive hypermedia system was called, *An Intelligent Aid to the Mathematics Syllabus*. Though the hypermedia document is still in a developmental stage, it demonstrated how the potential of hypermedia may be realised in the presentation of syllabus documents. The user interface of my original prototype was based on the book metaphor (Barker, 1991; Barker and Manji, 1991) and the *complementary* partnership metaphor (Heylighen, 1991). The user characteristics used to develop this prototype are listed in Appendix 1.

A hypermedia version of curriculum documents has the potential to allow the presentation to be more user-friendly and take into account the different learning styles and knowledge of teachers. The two scenarios presented in Figure 1 use an example to compare and contrast the two methods of presentation for the same task. Scenario 2

highlights what is now possible using current hardware and software to present information in a hypermedia form for teacher use. Bevilacqua (1989) gives a similar scenario for students using reference materials.

Scenario 1 - Hard copy of the syllabus	Scenario 2 - Hypermedia version of the syllabus
<p>Teachers locate the relevant copy of the curriculum from the library or teachers' resource room. They then either sit down and access the document or carry it home.</p> <p>During the reading they come across a term they need to clarify. They look up in the glossary and it is not there. If it is important enough, they could decide to stop and look-up in a dictionary, this may involve a number of dictionaries if they are available.</p>	<p>Teachers sit down at a PC, at home or work and begin by opening up a subject curriculum and level they are interested in.</p> <p>During the reading they come across a term that needs to be clarified. They look up the word by clicking on it. The system then offers the choice of a number of glossaries and dictionaries that are available. If the word is not available, the system allows the user to access to a larger system that contains a much larger range of specialised dictionaries. The teachers then could copy the definition into the system they are using.</p>

*Figure 1: Two scenarios, that compare and contrast the two methods of presentation for the same task*

## The significance of the study

One of the greatest challenges today in education is to encourage teachers to use newer information technology to transform education to be relevant for our society. Thomas and Knezek (1991, p 265) in their article *Providing technology leadership for restructured schools*, state "schools must be restructured to accommodate the increase in information and the technology used in harnessing that information." Can new information technology tools (Horn, 1991), such as hypermedia and 'organic' (having the ability to grow) expert systems allow teachers better and quicker access to syllabus



and other curriculum information? If this is so, can their use reduce the time needed to access the information and increase the range of information that is readily accessible by teachers? These questions form the backdrop to this study.

Firstly we must consider whether curriculum materials for teacher use are suitable for hypermedia presentation. Clearly the literature indicates that textual materials that are not meant to be read sequentially like a novel, are suitable for presentation in a hypermedia form (eg. Carlson, 1990; McKnight, Dillon, and Richardson, 1989; Rada, 1992; Persico, 1992). At present, curriculum materials for teachers contain the correct content but often lack in quality of presentation. This lack in quality of presentation can take many forms, from poor referencing of the material, to poor layout of text and graphics. Poor referencing can range from poor table of contents, to none, or very limited indexing of the contents. For example, when looking at the syllabus entries in the Western Australia Mathematics syllabus produced by the Ministry of Education (1989), there is no content page, there is no index, and the pages are unnumbered. This syllabus is also poorly packaged, as it comes in two large ringed folders that are difficult to carry around to access information when needed and it is conceivable that pages would soon go missing.

Not only could hypermedia address quality problems inherent in hard copies but it could also address the economic problems that syllabus materials are expensive, hard to correct, and slow to update. Hypermedia has the potential to overcome these limitations and to offer easy access to much richer information (Rawlins, 1993). This enriched information can take many forms from simply showing areas that are covered in other subject areas to information on how to teach, when to teach and methods of remediation. This new medium may allow teachers for the first time to truly integrate their teaching programme by being able to access and manipulate multiple curriculum documents simultaneously. As Thomas and Knezek (1991) predict, technology "will dissolve the boundaries traditionally imposed on curriculum" (p 271) and that the

curriculum will become "seamless, and, rather than simply writing across the curriculum, we see maths, science, social studies, language arts, and fine arts intermingled" (p 272).

Studies that have looked at teacher stress (Yuettemann and Punch, 1992; Solman and Feld, 1989) have identified a number of stress factors. A number of these stress factors, such as time demands, curriculum demands, changing curriculum and access to facilities, could be reduced by the introduction of curriculum material in a hypermedia format. This would be a significant step as typically between one in five and one in three teachers report that they find being a teacher causes much or extreme stress (Solman and Feld, 1989).

Although this paper takes a positive and optimistic view of the potential of hypermedia, major challenges are facing anyone trying to create and implement such a program in this new medium. As Venezlsy and Osin (1991) point out, technology in education "is a discipline in which broken promises stand out like dried cornstalks in the winter fields" (p 27). The problems related to system compatibility, software obsolescence and software maintenance are a major concern in the development and implementation of a hypermedia program, especially in the educational field which is usually poorly funded. The design and maintenance of reliable and valid articulation among the components of the syllabus is a major challenge for any school system, even centrally administered. There are also difficulties faced by teachers in gaining access to computers at school and at home.

## **The purpose of the study**

The purpose of this study was to investigate the potential of hypermedia applied to curriculum materials that are for the sole use of teachers. The study was concerned with the potential for overcoming some of the impediments of information dissemination

and curriculum implementation by typically overworked teachers (Marsh, 1988) by using hypermedia materials in place of the hard copy curriculum documents. The main advantages of this technology are: a more user-friendly document that is interactive, non-sequential allowing non-linear access to different types of information that enhance and enrich the standard syllabus material. Three areas were investigated; hypermedia, teachers, and curriculum documents.

This study set out to investigate the likely acceptance by primary school teachers of this proposed new form of syllabus information presentation. A working model of this type of application which was developed for the Western Australia Mathematics syllabus (Ministry of Education, 1989) demonstrated the possibilities of this new medium. This research can only be of a preliminary nature because we are only at the embryonic stage of this new era of electronic information.

# Chapter Two

## Review of the Literature

### Introduction

For decades educators have heralded the arrival of the 'Electronic Age' (McLuhan and Powers, 1989) and discussed its potential impact on schooling. The challenge today is to encourage teachers to use new information technology (Hannafin and Savenye, 1993). Johnson and Grover (1993) found that computer software has not delivered the results hoped for in schools as the "overall quality of instruction is relatively poor" (p 5). Callen (1991) has found that even after more than a decade, computers "have failed to be taken seriously as an educational tool in many classrooms" (p 26). As Kay (1990) aptly noted, just placing a piano in every classroom will neither produce musicians nor music literacy. Similarly placing computers into schools, as it has occurred until now, does not produce computer literate and computer using teachers (Randall, 1989). Part of the problem has been that most teachers have not experienced the computer in their own schooling (Wilson, 1990). It is also a generally held view that they are a conservative group, resistant to change. Bork (1991), stated that "the best hope is to use the computer itself as the learning vehicle for teachers, as well as for students" (p 35).

One of the reasons repeatedly put forward for the failure of information technology (IT) to live up to expectations has been the lack of software for teacher learning (Ridgway, 1991). If classroom teachers are to integrate technology into their curriculum, they must experience its use in their own learning situations (Irwin, 1990). For teachers to realise the potential of the technology, for themselves as teachers, and for their students, they must experience and use these modern technologies.

Thomas and Knezek (1991) state that "technology makes it possible for teachers to have the best information" (p 270). Advances in computer hardware and software in recent years have taken hypermedia from the realm of theory to practice in educational settings (Haavind, 1990; Johnson and Grover, 1993). New information technology tools, such as hypermedia and expert systems may allow teachers better and quicker access to syllabus and other curriculum information (Dede, 1989; Fishman and Duffy, 1993). If this occurs, their use could reduce the time needed to access the information and increase the range of information that is readily accessible to teachers. However these educational applications have largely focused on teacher to student instruction or student use in learning (Ambron and Hooper, 1990).

To gain an understanding of this situation one needs to consider and connect three areas of interest. Firstly, we need to consider curriculum dissemination, then the development of information systems and finally the emergence and evaluation of hypermedia.

## **Curriculum Dissemination: The Present Situation**

The curriculum is central to school-based education and to the work of professional teachers. The state education authorities are the main issuing bodies and teachers are employed by schools to implement the stated curriculum. The curriculum sets out to answer fundamental questions for the teacher. Print (1988, p 2) expressed these questions as: "What to teach? How to teach? When to teach? What is the impact of teaching?".

In the short time of mass education, much has been written on what is the curriculum. The range of definitions is very broad, from the school to subject areas, and from planned to hidden (Marsh, 1992). The syllabus is a "subset of the curriculum" (Print, 1988, p 2). Typically the syllabus is a list of content areas and objectives that are to be taught and assessed. Depending on the school subject being covered, the syllabus may

be of major or minor importance. Where the subject area has a high content base, such as in mathematics, the syllabus takes on a dominant role (Pusey, 1976). Teachers are required to develop teaching programs based on the supplied curriculum. The software prototype which will be used in this study contains syllabus documents and other curriculum documents that are designed for teacher use in the development of their teaching programs and lesson materials in mathematics.

## **Curriculum Implementation**

A teaching programme has a number of functions, one being a means of accountability to the school administration, regional superintendent and parents (Pusey, 1976). The education authorities in all states require teachers to base their programmes on the curriculum documents provided. Thus the starting point for all programming is the reading of the curriculum documents. Primary school teachers are in a unique situation compared with high school teachers in that they are often responsible for the teaching of all subject areas. Because of time constraints, or perceived learning benefits, they may need to combine different subjects within one unit of work. This strategy is known as integrating the curriculum (Mathews, 1989; Brady, 1989). It is interesting to note that, Dede (1989, p 26) suggests that "Hypermedia would enable a long-standing instructional goal: an integrated curriculum" or "a seamless curriculum" (Abramson, 1992, p 42). To develop these integrated teaching programs teachers need access to a range of curriculum documents. This could be in a hypermedia format (Abramson, 1992; Smith and Westhoff, 1992; Fishman and Duffy, 1993; Yankelovich, Haan, Meyrowitz and Drucker, 1988; Thomas and Knezek, 1991).

This study is interested in two problems associated with the use of syllabus documents: the increasing rate of change within society, which is reflected in the increasing rate of change in syllabus documents, and how this material is disseminated and implemented. The increasing rate of change places a great burden on already overloaded teachers to keep up to date with current teaching methods and curriculum materials (Hargreaves,

1992). Just as students were once considered empty vessels to be filled with knowledge and were all at the same level, it seems that at times, reading the curriculum literature, teachers are viewed in a similar way. The 'boss-employee' relationship tends to be fostered by the bureaucratic style of the departments of education (Pusey, 1976). This seems to breed an attitude that all that needs to be done is to pour in the new syllabus document and by magic, the teacher becomes an expert.

The implementation of a curriculum is putting it into practice in the classroom (Pusey, 1976). Material production, distribution and communication with teachers, to allow for this implementation, is a major logistical operation. There are many barriers to this communication outside and within schools (Strurman, 1989). The major barrier (Marsh, 1988) is that the teacher is already "inundated with pressing day-to-day problems that require immediate solutions" (p 47) and thus finds it difficult to find the extra time required to do the things needed to implement a new curriculum, such as learning new skills and knowledge and preparing new materials.

Mash, Willis, Newby, Deschamp and Davis (1981) carried out a detailed study of selection and distribution of curriculum materials within primary schools. Some of their findings were that: materials were often poorly organised, there was insufficient time to select materials and a lack of knowledge of what was available, and little information was available to teachers on the past or present use of materials by other classes. In two studies on stress in the teaching profession Solman and Feld (1989) and Tuettemann and Punch (1992) both found that 'time demands', 'access to facilities' and 'curriculum demands' were significant stress factors.

## **Curriculum Evaluation**

Print (1988, p 142) makes the point that curriculum evaluation is a relatively recent term, teacher evaluation being a part of this process. Evaluation is usually concerned with classroom and student-teacher interaction. My own finding from the literature, in

agreement with Lowe (1989) and Chinien and Hlynka (1993), is that unfortunately there are few published accounts that focus upon the practical aspects of evaluating curriculum materials and how they are presented. Lowe (1989) states that more importance should be devoted to the cognitive characteristics of the students, I would also add the cognitive characteristics of the teachers and to the complex relationship between the text, graphics and content (Olsen, 1991). Chinien and Hlynka (1993) also noted that there seems to have been no evaluation of different methods of presenting the curriculum material to teachers.

This lack of evaluation of the curriculum materials is striking when one considers the range of materials that have been produced for teachers. There seem to be different standards operating when it comes to presentation and usability, between teacher and student material. The finish and usability of teacher materials is often well below that produced for student use. For example the teacher materials are often poorly indexed and often only the chapter headings are in the table of contents. Also little consideration is given to the differences in teaching experiences and knowledge of the teacher when the materials are produced.

The above can be no more than a personal observation, as very little work in this area has been carried out. As Chinien and Hlynka (1993) found, in the United States, only about 1% of textbooks are systematically evaluated and revised and slightly over 1% of school television material is learner verified. While Mirel (1991) examined 22 experimental usability studies of hard copy documentation that appeared between 1980 and 1989 and found a 'cumulative laxity' in the current evaluation procedures.

The question of the quality of the curriculum documents, such as the syllabus, presented solely for teacher use, seems to be of minor importance or not considered at all. Armstrong and Shutes (1981) have developed a 'Curriculum Document Assessment Instrument', after finding a "tendency for school districts to strive first to meet the



objectives of *having* a written curriculum structure and to consider only secondarily the issue of curriculum document *quality*" (p 200). They do not define quality, but include it within the 'overall acceptability' of the curriculum document. Of the 12 criteria used in their 'curriculum document assessment' instrument, half are devoted to evaluating quality of presentation. It should be noted that in the literature (eg. Nielsen, 1990) the term usability is often used in place of quality.

Usually only the curriculum materials that are going to be used by students are included in the evaluation literature (Marsh, 1988). In recent discussions with departmental officials, on teacher curriculum material, they stated to me that presentation is firstly dependent on cost and then on what the designer and developer consider appropriate. Usually there is little or no consideration for how the document will actually be used by practising teachers. The characteristics and range of abilities of the teachers does not appear to be considered when it comes to the dissemination of curriculum documents. When evaluation does occur, it is generally carried out within the education departments and is not written up for general distribution. From this it would appear that as far as the education authorities are concerned, as long as the content is all there in the documents, it does not matter that access may be difficult and time consuming (Armstrong and Shutes, 1981).

Current curriculum materials for teacher use still reflect the author's assertion that the usefulness of the documents is not considered. A good example of this is the Ministry of Education (1989) *Learning mathematics pre-primary to stage seven*, this curriculum document is in my opinion difficult to use, due to its size and poor indexing and referencing of the material. Can this major problem of usefulness of curriculum materials be addressed by making use of the potential of hypermedia? The information should be easy and quick to access and for the first time the different learning styles and knowledge of the teacher can be catered for. The ability to link syllabus documents with other materials such as teaching resource materials, other subject areas documents and

so, will be a major enhancement to the current documents (Emery and Ingraham, 1991; Smith and Westhoff, 1992).

## **Historical Development of Information Systems**

We are passing through a time of great technological change. Society is moving from the industrial to the electronic or information age (Toffler, 1970; McLuhan and Powers, 1989). This change will be as great as the introduction in the 15th century of the printing press, which marked the end of orality and the start of literacy. As this new age dawns we are just beginning to understand the first one, that of orality (Ong, 1990). We are so immersed in print, reading and writing are such a part of our way of life, that it is difficult to conceive of a time when the only recording machine was the mind.

### **Information Storage**

Every new type of information storage device has allowed humans to store more data, of an increasing range and quality. The earliest was the mind and the latest is the optical disc on which we store data electronically (Gery, 1989). Just as the printing press was the technology behind print, the computer is the technology behind this new storage and presentation of information, in the form of electronic text. This can be viewed as the evolution of information storage and access. Between the mind and the computer the information was in a physical form that could be 'found and located'. Libraries give a great deal of thought to the spatial arrangement of information. With this new form of information storage "we can no longer go directly into the storage system to take the information in hand." (Bolt, 1984, p 5), instead we must interact with the computer. The spatial location of the information is no longer important to the computer but to the user (Marcus, 1993). The spatial location of this information is important as "psychological research supports the notion that people learn readily, and without effort, the whereabouts of things in space" (Bolt, 1984, p 5). Thus in developing the interface

display one must consider the spatial location of data (Brafield, Rosenberg and Levasseur, 1991; Marcus, 1993)

If we look at the two ends of this evolution of information storage and access, humans and computers have a number of interesting similarities. They both have short and long term memory. Short term human memory is very limited compared to computer short term memory, it has been estimated to be no more than  $7 \pm 2$  chunks stored simultaneously (Heylighen, 1991) or even less, 5 to 7 chunks (Marchionini, 1992). Long term memory for both is very large and can be accessed by "recall or recognition" (Heylighen, 1991, p 493).

Due to the characteristic differences between human memory and computer memory, a number of paradigms have been suggested for conceptualising the relationship between humans and computers: *conversation, an agent, complementarity* to name but a few (Heylighen, 1991 and Storrs, 1989). I favour the complementarity metaphor, that is letting the computer do what is difficult for the human and vice versa. That is a symbiotic relationship. Hypermedia fits this paradigm well, the electronic information is presented in a way that the user (reader) is familiar with. It is not an electronic page turner, but it allows the information to be viewed as if we were using our own minds, that is based on associations and non-linearity of thought (Franklin, 1989; Ellis, 1991).

## **Secondary Orality**

Ong (1990) discusses the profound changes in thought processes, in personality structures and consciousness brought about by the invention of writing and reinforced by printed text. He reviews and interprets the extensive work done over the last 20 years on the differences between orality and literacy. The shift from oral to written speech is essentially a shift from sound to visual space. The electronic age brings sound back into communication and Ong (1990) has termed this 'secondary orality'. McLuhan and Powers (1989) cover the same topic but in a broader and more philosophical

manner. They similarly state that the electronic age is “displacing visual space and retrieves acoustic space in a new form” (p 19). Both studies hold many insights that are of value in the study of the transition we are in: the early stages of our passage from paper text to electronic text (Tuman, 1992). Electronic text includes print, sound, graphics and video.

We are now entering the *secondary orality* age as described by Ong (1990, p 136). Starting with the telephone and progressing through radio, television and to the present with hypermedia, technologies are all contributing to what McLuhan has called the *global village* (McLuhan and Powers, 1989). Just as it is difficult to imagine the past without books, our view of the future is limited by our imagination. It is difficult to remember that not too long ago readers had to learn to read silently and books were chained-up in special rooms. When Western Union was offered all the rights to the invention of the telephone in 1877 the president turned it down, asking “What use could this company make of an electrical toy?” (Young, 1991). Just a short time ago computers were housed in special buildings and one took punched cards to them for processing.

Ong (1990, p 79) mentions that many of the fears associated with the introduction of the computer were also raised by Plato about writing: “it is inhuman, pretending to establish outside the mind what in reality can be only in the mind. Writing destroys memory and weakens the mind”. Thus when introducing any new forms of information dissemination, it is important to consider their social acceptability.

## **Print**

Print as we know it in hard copy is now being complemented and replaced by electronic text also called softcopy (Tuman, 1992; Basch, 1991). This electronic form now may contain printed text, speech, graphics and video. Most printed material is currently composed and published electronically. Published products have been available in

electronic form for the past few years. A few examples of this that are now available on CD-ROM: all the Australian telephone directories are now on one CD-ROM, the Grolier Multimedia Encyclopedia, Microsoft Bookshelf, Culture (Eversole, 1989), Beethoven's Ninth Symphony (Haavind, 1990) and Discis Books (Johnson, 1991). These are indications of but the early stages in the movement towards the age of 'secondary orality'.

Our concept of what print is will change as we move into this new age (Tuman, 1991). Print as we know it today creates a sense of closure not only in literary works, but also in analytic, philosophical and scientific works (Ong, 1990). Hypermedia at present does not have this sense of closure. Texts in various scripts around the world are read variously from right to left, or left to right, or top to bottom, or all of these ways at once as in boustrophedon ('the ox-plowing' pattern) writing, but never anywhere, so far as is known, from bottom to top (Ong, 1990).

In western culture this left to right reading pattern and the rectilinear page format is so strong that they are quickly incorporated into our subconscious. Hypermedia with its ability to 'jump' or branch has the capacity to alter this pattern of reading. At present western readers give more importance to left hand portion and lower area of any visual display (Jonassen, 1982). In developing any new medium, such as hypermedia it will initially be necessary to build on the familiar framework that print and other existing media present, before it will be possible for the new medium to develop its own unique characteristics. Interestingly, no specific standards exist at present for building electronic text, even though we are changing rapidly to a situation where all texts will be in electronic form at some point in their production.

## **Evidence of Change**

Shay (1991) in 'Productivity in the Information Society' contrasts the industrial era with the new information era. The three driving forces of change he mentions are: new

technologies, especially information technologies, new values and lifestyles, and the new competitive global economy. The new technologies are based on information processing and change the way we do things. They give rise to flexible manufacturing systems that can be reprogrammed quickly to make different products on the same assembly line. Interestingly, three-quarters of the things manufactured in the United States today are made in runs of fewer than 50 items. Old technologies used machines to increase our *physical* power: strength, speed and precision. The information technologies extend our *mental* power (Shay, 1991). Hypermedia is a good example of this new technology.

A symptom of the movement towards this new era is the rate at which change is occurring. The current computer base has taken only twenty years to reach the same level it took telephones 75 years to achieve (Stix, 1993). The average United States family now has 10 radios from a base of none about 75 years ago Shay (1991). The half-life of a professional (the length of time before half of what a professional knows becomes obsolete) is decreasing at a quickening rate. At Hewlett-Packard, the half-life of an electronic engineer is now five years and that of a software engineer is two and a half years (Shay, 1991). Thus professional training is now becoming a life long process. An interesting question to consider is, what is the half-life of a teacher? Brickhouse and Bobner (1992) state that at present "unlike other professions, teachers are often treated as if they were *finished products* when they graduate from their teacher-education programs" (p 483) and would thus not have a half-life! Can hypermedia help to assimilate and manage this expanding mass of information which teachers have to deal with, as they are not *finished products*.

# Hypermedia

## History

The modern concept of hypermedia has grown from an earlier concept of hypertext. Hypertext has its beginnings back in 1945 when Bush (1986) described a system we would now call hypertext. He called his system Memex ("memory extender") and although he described it in theory, it was never implemented. Interestingly Doug Engelbart, the inventor of the mouse, was partly inspired by reading Bush's article in 1945. Twenty years later in 1962, Doug Engelbart started to work on the Augment project (Tsai, 1988), developing computer tools to augment human capabilities and productivity. One part of this project was On-Line Systems which is credited with being the first operational hypertext system (Ellis, 1991).

In 1964 Ted Nelson conceived Xanadu (Tsai, 1988; Ellis, 1991), an interactive multimedia repository that would hold the textual, auditory, and visual information of human civilisation (Tuman, 1992). In the process he "coined the term 'hypertext', or non-sequential writing, to refer to non-linear text which would be inconvenient to produce or represent on paper" (Ellis, 1991, p 6). It is only now that most of the technology is available that a commercial version of Xanadu is being released.

In 1987, Apple introduced HyperCard (Goodman, 1987) free with every Macintosh. This, for the world at large, marked the start of hypermedia. During the same year the Association for Computing Machinery (ACM) held its first conference on hypertext. Finally hypertext had come of age, hypermedia was born. Other similar hypermedia authoring systems have since been developed such as Asymetrix ToolBook and IBM LinkWay.

## What is Hypermedia?

When the term hypertext was first used by Ted Nelson “alphanumeric characters were the primary input-output mode for computers” (Jones, 1991, p 115). Now that it is possible to use various other media, the term hypermedia is used instead. There seems to be no special need to have two terms, one for text and the other for other types of media. Although at present they seem to be used interchangeably, I will use hypermedia to refer to both terms. Another term widely used now is multimedia or interactive multimedia. However, not all multimedia programs are hypermedia even though all hypermedia programs are multimedia (Nielsen, 1990; Marchionini and Shneiderman, 1988; Ellis, 1991).

In deciding if a system is an example of hypermedia, I agree with Nielsen (1990) that the “look and feel” of its user interface is what is important. The user interface is concerned with the method by which the user communicates and controls the computer (Marcus, 1993). In the past this has been mainly through the command line or text user interface (CLI or TUI) (Marold, 1993). This is the oldest form of computer communication. The graphic user interface (GUI) is graphical rather than textual based and selections are usually made by clicking a button on the mouse (Marcus, 1993). The Macintosh introduced (GUI) and “rewrote computing history” (Brown, 1992, p74). Now all other computer systems are following this lead. The GUI is the interface used in most hypermedia systems.

The GUI must make the users feel that they are in control and can move freely through the information, according to their own needs (Marcus, 1993). Designing and evaluating the user interface and devising methods of navigation have become major issues in developing hypermedia systems (Nielsen, 1990; Carlson, 1990). GUI allows the users to choose for themselves the order in which to view information which is non-linear. This has the potential to be more efficient, appropriate and understandable for



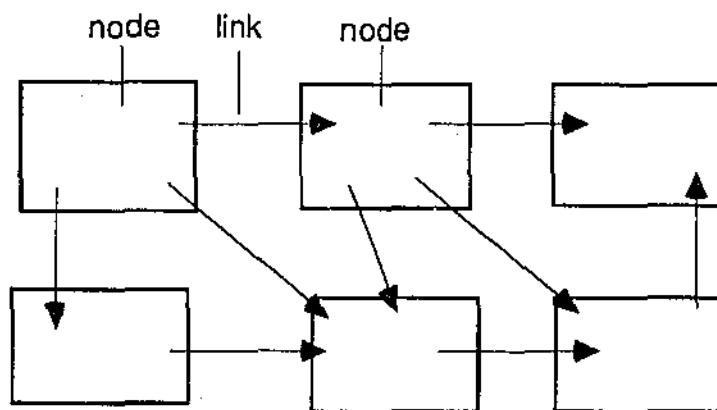
the user, it is in marked contrast with printed and the present software database material (Nielsen, 1990; Barrett, 1988, 1989).

While the best way to define and understand hypermedia is to use it, a useful method is to contrast it with other formats of the media, like a book, video tape or a computer text file (Kahn, 1989). In these latter cases the information is stored sequentially, that is the user is locked into the sequence as set out when the information was produced. In contrast to the hard copy, a hypermedia document allows information to be viewed nonsequentially (Tsai, 1988). The user must decide in what sequence the information is to be viewed. This becomes possible only with the computer because it allows random access to information in very short time periods that appear seamless.

To emphasise the different reading styles required between traditional passive *reading* of linear text and active *reading* of hypermedia the terms *browsing* or *navigating* are used (Marchionini and Shneiderman, 1988; Tuman, 1992). Browsing occurs when one is just *looking around* within the hypermedia document. However, when one has a purpose or direction, one is said to be *navigating* within the hypermedia document. This active reading adds greatly to the cognitive load of the user and is discussed later in this paper. Depending on the author, the presentation of the information may be highly structured or very open ended (Tuman, 1992). Each unit of information is called a *node*. Although this is the technical term, other terms are at present often used such as *windows*, *control buttons*, *labelled tokens* or *hot zones* (Venezky and Osin, 1991). The pointers between nodes are called *links* (Park, 1991). The links may be with the node as a whole or only a part of it, see Figure 2 (Tsai, 1988).

Another way to define hypermedia is to compare hypermedia with conventional software databases, database management system (DBMS) which are used to store data. In this case we could define hypermedia as: *an associative information management system* (AIMS). Table 1 gives a comparison of AIMS and DBMS

software (Franklin, 1989). The DBMS relates information in a highly structured way, whereas AIMS relates information in ways that are open ended and by association via links that are meaningful to the user. This definition of AIMS reinforces the idea of this technology as a means to augment human associative thought and memory. See Franklin (1989) for a complete discussion of this comparison and for a glossary of terms widely used in discussion dealing with hypertext.



*Figure 2: A small hypermedia structure showing six nodes and nine links*

Copeland (1991, p 155) describes interactive multimedia as a “multi-message system”, which “incorporates many of the message systems that were previously only facilitated by using a range of different media”. This range of separate media included such devices as text books, slide projectors, video recorders, etc. Copeland (1987) in an earlier paper differentiated information flow into the four meaningful dimensions of Static and Transient, Exposition and Inquisition (see Figure 3). The different message system could now be placed on this model, with mutual exclusivity.

The significance of this model is that it demonstrated the tremendous utility and usability of hypermedia. This is because hypermedia occupies the central location of Figure 2, from where it can take on aspects of all other media depending on the type of communication required. As Copeland (1991) put it,

For the first time, the message systems employed by a medium could be invoked according to the communication task in hand: transient and expositional one minute, static and inquisitional (ie asking questions) the next (p 154)

Table 1: Distinctions between Hypermedia and DBMS software (Franklin and Kimmell, 1990)

Characteristics	H'media	DBMS	Characteristics	H'media	DBMS
<b>Basic Unit</b>			<b>Information Focus</b>		
Node	√		Divergent	√	
Record		√	Convergent		√
<b>Components</b>			<b>Retrieval Method</b>		
Buttons	√		Browsing	√	
Words	√		Searching		√
Fields		√	Sorting		√
<b>Connections</b>			<b>User-Data Relationship</b>		
Links	√		Interdependent	√	
Relations		√	Independent		√
<b>Design Philosophy</b>			<b>Information Structure</b>		
Open	√		Self-evolving	√	
Closed		√	Imposed		√

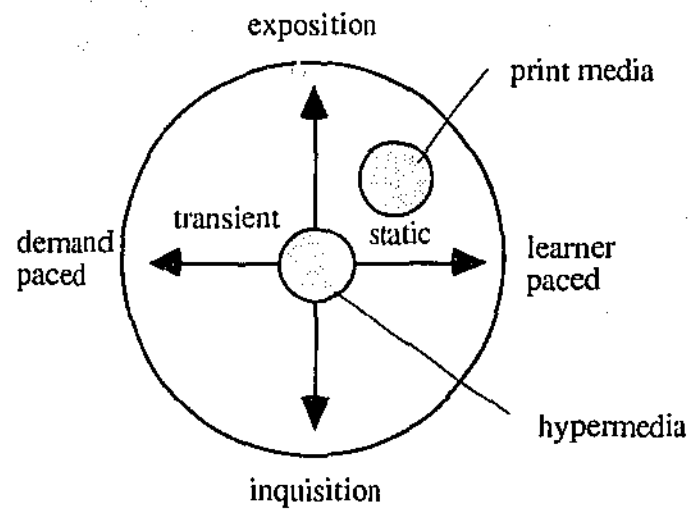


Figure 3: The four dimensions that differentiate information flow (Copeland, 1991)

## The Evaluation of Hypermedia Documents

Clark (1983) in an extensive review of the effects of different media on changes in educational achievement concluded that the importance of good educational content was more significant than the medium. However as the technologies of the different media become more sophisticated and merge into interactive multimedia, of which hypermedia is a subset, it is becoming possible to identify unique features, that if skilfully used, can make a difference in learning outcomes (Copeland, 1991). Well-structured analyses of how the critical features of a technology impact on users are needed (Charney, 1987). This is especially true of hypermedia documents. We do not yet know what constitutes a "good" hyperdocument and how best to use such a medium (Nielsen, 1990). The design characteristics of hypermedia systems are still being developed at this early stage. No standards have yet been set for the evaluation of hypermedia documents, nor for their classification. As Hardman (1989, p 34) comments "very little is published about the good, or bad, aspects of a completed hypertext". Even the term hypermedia document has not been agreed upon and in a number of journals the term electronic books, electronic text (e-text), hypertext or hypermedia documents are used (Basch, 1991; Barker, 1991).

Barker (1991) has developed a taxonomy of six basic classes of electronic books. The different categories are based on two fundamental criteria: 1) the nature of the information which an electronic book embeds: 2) the types of service which it is able to provide. The six categories are: text books, static picture books, moving picture books, multimedia books, intelligent electronic books, and telemedia books.

Evaluation procedures are still being developed for this type of medium since the technology is changing rapidly. The hardware and the authoring software are becoming cheaper and more sophisticated and as a result the medium itself has not yet stabilised

making any form of evaluation difficult at present. Gutierrez and Boder (1992, p 196) found that "evaluation and quality control remain the poor relations in multimedia productions". However, what is emerging from the literature is that the evaluation of usefulness or usability will be of major concern. Gould (1991) covers all aspects on how to design usable systems. He defines useful, usable, desirable computer systems, as ones that can be easily learnt, that contain functions that allow user to do what they want, and that they like. Usability is a sub-part of what Nielsen (1990) calls system acceptability and their relationship can be seen in Figure 5.

### System Acceptability

The term *system* is used loosely in the literature and I have taken the definition given by Whitefield, Wilson and Dowell (1991). They defined the *system*, in terms of ergonomics as 'a user and computer engaged upon some task within an environment'. By slightly modifying this definition it is possible to describe the system for both the hard copy and the electronic copy with a number of equations (see Figure 4), with the product being the information plus the medium in which it is published. The equation shows that if the information is held constant then the variables are the user, paper versus computer and differences in presentation. These variables are explained and developed in the next section.

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**System** = user + product

**User** = the individual using the product

**and Product** = the medium + information + presentation

Note: When the medium is changed the user remains the same but the product and system are different.

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*Figure 4: The term system explained*

Nielsen (1990) developed a model for evaluating the system acceptability (see Figure 5). The overall or system acceptability of a product, be it in hard copy or electronic form, is a combination of its social acceptability and its practical acceptability. User acceptance on both levels will determine whether an innovation is a success or not. A

simple model of the various parameters associated with system acceptability are shown in Figure 5. This model although developed for evaluating traditional computer systems can be adapted for use in evaluation of this new computer medium and for comparison with the existing medium.

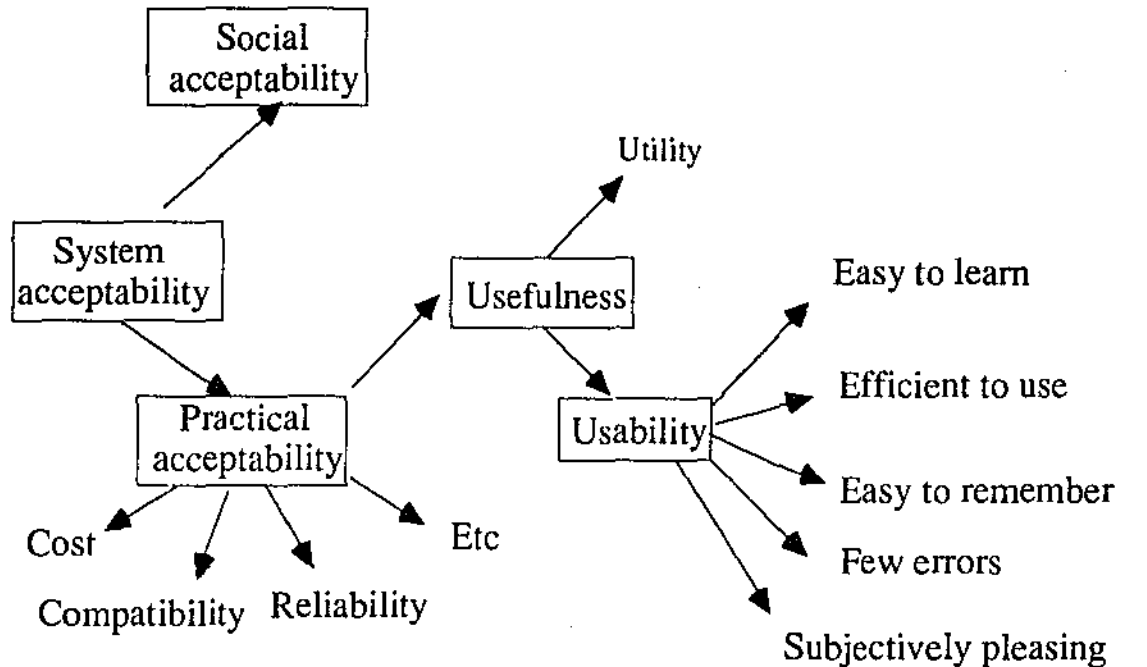


Figure 5: The various parameters associated with system acceptability (Nielsen, 1990)

## Social Acceptability

Social acceptability (Nielsen, 1990) is concerned with the social attitudes of the society at large and the users in particular towards the product. These are often intangible, but are very important if the product is to be accepted. An important aspect of social acceptability is the resistance to the introduction of new technology. Hannafin and Savenye (1993) discuss this important aspect in terms of teachers resistance to a new role in the classroom that computer use could bring about. Fine (1986) found that 20 percent of library staff will actively or passively resist the introduction of new technology. This figure has remained consistent since 1979 when the first study was completed. Nordenbo (1990) found in his study of adult computer novices, that they

perceived information technology: as a *threat*, as an expression of the *latest thing* and as a *challenge*.

Thus a poor social acceptability rating of computer technology by teachers on the whole could help to explain their low level of usage of computer technology (Hannafin and Savenye, 1993). As Randall (1989) found "too little attention has been given to human concerns about change, particularly the technological change analysts face as they design and install new information systems in schools" (p 161). Also contributing to this failure is the lack of teacher training and teacher involvement in the production of software and in the supply of hardware (Smith and Westhoff, 1992).

### **Practical Acceptability**

Practical acceptability (Nielsen, 1990) can be subdivided into various categories such as cost, compatibility with existing systems, reliability, portability and usefulness. Nielsen (1990) explained usefulness as "whether the system can be used to achieve some desired goal"(p 144). This can be further broken down into the two categories of utility and usability. Utility here means whether the system can do what is needed or required. Usability is how well or easily you can do what is needed or required. Acceptance of hypermedia will largely depend upon its usability (Nielsen, 1990).

### **Usability Parameters**

Traditionally, usability is associated with five parameters: easy to learn, efficient to use, easy to remember, few errors and pleasant to use (Nielsen, 1990). Usability can be defined as the interaction between user, task and computer (Whitefield, Wilson and Dowell, 1991). In a hypermedia system the user interface is what determines usability and how well it will rate on the five parameters given above. The user interface is that part of an interactive system directly concerned with the user interaction with the computer (Marcus, 1993; Storrs, 1989). It supports the two-way flow of information

between computer and user. The user interface must be designed consciously and thoughtfully and will consume more than 40% of the software (Curtis, 1991). A user with content expertise but no experience with the system should be able to use it effectively without assistance or instruction, at the same time an experienced user should not be impeded.

*In the 1990s, usability will become a crucial product differentiator in the marketplace, and products will compete based on the usability of their human interface. (Curtis 1991, p15)*

Although several methods exist for evaluating how well a given user interface scores on each of these primary usability parameters, they have not been applied to hypermedia systems. Both Whiteside, Bennett and Holtzblatt (1988) and Gould (1991) offer good reviews of this field. However, although the literature on hypermedia has been enthusiastic and visionary, little evaluation has been carried out (Hardman, 1989; Gutierrez and Boder, 1992), as Nielsen (1990) explains,

*Most discussions of hypertext usability are not founded in measurements of the usability parameters but are more in the nature of conjectures based on personal experience. (p 143)*

A hypermedia system has two main user groups, the browsers and the authors (Tuman, 1992; Marchionini and Shneiderman, 1988). Therefore most hypermedia systems have browsers and authors modes of operation. The browser, in its most basic operation only allows the user to look and move about the information. The author mode allows the user to reprogram or change the system. The hypermedia system often allows the user to range between these two extremes (Horney, 1993).

## **The usability of hypermedia documents**

In a wide ranging review of existing research on usability of hypermedia McKnight, Dillon and Richardson (1989) highlighted four issues relevant to usability:

- reading from screens as opposed to reading from paper;



- reading behaviour, particularly how and why different texts are read;
- interface design variables such as display size and manipulation facilities;
- user navigation.

### *Reading from the Screen*

New screen technology is overcoming problems concerning readability from the screen. Past research (Dillon, 1988) has shown that reading efficiency was lower from the standard computer displays of the 1980s than from paper. Dillon, McKnight and Richardson (1988) however found that "reading from screens can be as fast and as accurate as reading from paper" (p 463). Muter and Maurutto (1991) repeated earlier studies using current display technology (high-resolution screens with black characters on a white background) coupled with variations in textual format and found that reading speed and comprehension were equivalent for the high-resolution screen and the book.

Not all printed materials are suited for screen presentation, when one considers current technology, user preferences and classes of text. Rada (1992) has identified two widely different classes of text as reference text and the novel. Reference text such as repair / technical manuals, reference materials, telephone directories, dictionaries, catalogues, encyclopaedias and tourist information, are not meant to be read from cover to cover. These texts are suited to conversion to hypertext, this has been done and is on the increase (Persico, 1992 and Rada, 1992). The novel may be difficult to convert into hypertext, as it "may be an extended stream of consciousness for which the logical structure is not suggested in the makeup of the document" (Rada, 1992, p 295). In these examples the type of reading behaviour is likely to vary greatly. Experimental work comparing hypermedia and paper version of these texts is lacking.

### ***Reading behaviour***

How and why text is used needs to be examined before one considers whether to present the material using hypermedia. Very little research has yet been carried out in this important area. As Horney (1993) states "a closer examination of just what the readers do and when they do it will lead to new developments in hypertext software and in the rhetoric of hypertext structures" (p 269). Gribbons (1991) in a detailed paper presents a model for both the development of effective displays and the diagnoses of ineffective designs of information products. We are still employing "18th and 19th century design conventions to solve 20th century information problems" (p 42) he claims and goes on to say that the "developments from the cognitive and perceptual sciences are seldom incorporated into the design of text books, instructional manuals, and numerous other categories of information products" (p 42).

Monk, Walsh and Dix (1988), in one of the few empirical studies that actually used a hypertext system, reported that readers performed better with a 'scrolling browser' than with a hypertext browser. Scrolling text files are the traditional means of accessing text on a computer. However, they did not originally use an overview map to help the users to orient themselves. By adding a paper map to the side of the screen in a follow-up experiment, performance noticeably improved in the hypertext presentation to where it was slightly better than the scrolling text file. This study represents only one type of task and user group, and experimental investigations in other situations are greatly needed.

### ***Interface design***

The user interface (UI) is the last frontier in computing and is likely to be a key technological issue in the 1990's (Gould, Stephen and Lewis, 1991; Hicks and Essinger, 1991; Marcus, 1993; Marold, 1993). The idea is to make the inner working of the computer as invisible as possible and thus reduce the cognitive load. Morman (1990) put it this way,

*Interfaces get in the way. I don't want to focus my energies on an interface. I want to focus on the job. My tool should be something that aids, something that does not attract attention and energy to itself. (p 210)*

The Graphic User Interface (GUI) as seen in the Macintosh or Microsoft Windows operating systems is an example of a direct manipulation interface, giving the user the illusion that they are controlling real objects (Heeter, 1991). This is achieved by using windows, icons, mouse and drop down menu bar which reduces the cognitive load and is called *affordance* by psychologists since the appearance of an object suggests how it should be used (Curtis, 1991). Thus the user need only recognise the correct icon command rather than remember it (Barfield, Rosenberg and Levasseur, 1991). At present the mouse is the dominant input device for the GUI. The appropriateness of an input device depends largely on the task and environmental conditions. For example a touch screen may be the best device in a public place where other devices require more learning and are less vandal proof (Hardman, 1989). Constantine (1991) mentions the following four points that interface designers need to study.

- Study *what* users actually do!
- Study *how* users do what they do!
- Study *what* users would want to do, if they could!
- Study *how* users would want to do things, if they could!

### ***Navigation***

Navigation and browsing are the terms used to describe the movement within the hypermedia system. Navigation tends to be used when the movement is purposeful and browsing when one is 'looking around'. There are usually a number of levels of navigation depending on how much control the user is given. Duchastel (1990) identified four cognitive processes that seem central to hypermedia interaction: browsing, searching, integrating and angling. When the navigational aids are poor the user will get lost in what is called 'hyperspace' (Nielsen, 1990). This occurs when the

users become frustrated at not knowing exactly where they are nor how to get out of their present location.

This need to understand how to navigate imposes a cognitive load on the user that is not present in the hard copy (Oren, 1990). This cognitive load or demand is related to the interactivity of the medium which according to Anderson (1988) needs to be related to three findings of cognitive science, that is, visual memory is easier and stronger and that "active prolonged engagement and construction of meaning is preferable for the better functioning of long term memory" (p 199). A major component of the GUI design will be taken up with developing 'good' navigational aids that will reduce the cognitive load (Marcus, 1993). At present hypermedia systems are at a primitive stage in presentation rhetoric (Gluck, 1990) and are heavily reliant on the presentation rhetoric of the book. Horney (1993) identified five navigational patterns: Linear Traversal, Side Trip, Star, Extended Star, and Chaotic and found it difficult to make comparisons as "most authors do not directly report data on the paths taken by readers through documents" (p 267).

*Perhaps the diversity of hypertext navigation found in the literature and the attendant difficulties of comparison they entail, indicates that researchers are prematurely reaching for definitions of reading or navigation "strategies". ... A close examination of just what readers do and when they do it will lead to new developments in hypertext software and in the rhetoric of hypertext structures. (Horney 1993, p 269)*

# Chapter Three

## Method

The focus of this study was to investigate the potential acceptability of a hypermedia system for the presentation of the Western Australian Mathematics Syllabus (K-7). The investigation made use of an evaluation model created by Nielsen (1990). In essence it involved some comparison of the existing hardcopy and the proposed hypermedia version.

### **The Model for Evaluating the Acceptability of a hypermedia version of a Mathematics Syllabus**

The evaluation of acceptability of a system or product can take many forms. Research and development in this area of evaluation have been very limited. Usually systems have been developed with little or no consideration of the user. "According to Komoski (1971) less than one percent of the 14,000 textbooks sold in the USA are systematically evaluated and revised ... slightly over 1 percent of television material used in schools are learner verified" (cited in Chinien and Hlynka, 1993, p 64). However for a product or system to be used as expected or as required it must be acceptable to the user. The model that was used in this study is shown below and is based on that of Nielsen (1990) which was explained in detail in Chapter Two.

Nielsen's model gives three general components of acceptability to evaluate:

- (A) Social acceptability
- (B) Practical acceptability
- (C) Usefulness

Each of these is further expanded in Table 2, to give specific components of acceptability to be measured in the comparison between the two media addressed in this study (print and hypermedia).

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*Table 2: Specific components of acceptability*

**A: Social Acceptability**

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medium anxiety	This comparison only needed to be concerned with computer anxiety.
gender and age differences	The question is, do male and female teachers view technology differently and does this affect the use of computer usage in schools? Do age and past computer experience have any influence on this?
credibility	Is the credibility of the information affected by the presentation medium?
cultural and social norms	These are very broad terms covering cultural and social norms of the user group that related to the product's acceptance.

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**B: Practical acceptability**

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complexity of medium	How hard is it to get the product up and running?
cost	What is the cost of the product? What is the cost of development and of in-servicing the users?
portability	How easy is it to move the product about?
compatibility	Innovation acceptance theory defines it as the degree to which an innovation is seen by users to be consistent with their existing values, experience, and needs. This is positively related to its rate of adoption.
storage capacity	How much and what types of information can be stored per unit area of product?
reliability	This consists of data reliability and software reliability.

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## C: Usefulness

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<b>utility</b>	Does the system contain the necessary information and does what it claims it can do?
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<b>Usability</b>	
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easy to learn (how to use)	The user is quickly able to understand the basic navigation options and use them to locate wanted information. They do not need to be familiar with the whole product to use part of it.
efficient to use	The number of operations required to achieve some goal is small. In moving around, the user is quickly able to orient themselves and to return to where they departed.
easy to remember	After a break from using the product, the user has no problem in remembering how to use and navigate within the product.
few errors	This refers to the ease and efficiency of accessing the information and to its accuracy.
subjectively pleasing pleasant to use	Users are rarely frustrated with using the product and feel they are in control of it.
easy to update	Can the product be revised, corrected and added to easily?
user assistance	Does the product offer help when the user has difficulties?
record structure	How is the information set out?
retrieval techniques	What methods are available to find information?

---

## General Research Question

This study firstly poses a general question:

*Can new information technology in the form of hypermedia assist teachers by improving accessibility to required information contained in school syllabi?*

At present computers are used in the production stage of the syllabus, all printed material is now being produced on computers, that is in electronic form. The question is

can teachers benefit from accessing this electronic text directly by using hypermedia technology rather than using the produced hard copy?

## **Relationship of General Research Question to the Evaluation Model**

The evaluation model developed for this study was used to investigate the general research question. For each of the model components of acceptability a general research question was proposed and these are set out below.

(1) **Social Acceptability**

Are there social acceptability factors that need to be considered which may hinder the effective use of hypermedia in presenting syllabus information?

(2) **Practical Acceptability**

Is hypermedia a practical alternative to the present hard copy of school syllabi?

(3) **Utility and Usability in general**

To what extent can a hypermedia version of a syllabus offer more information, greater accessibility and be a more efficient way of accessing this information?

In order to address these questions a comparing of the medium of dissemination of the syllabus is required, that is, a comparison between hypermedia documents and print documents. Therefore, on the basis of these research questions and specific components of the evaluation model a comparison of the two media under investigation is given in Table 3. From this comparison a list of questions was generated (refer to Appendix 2) from which the specific research questions were selected and developed. These are listed in the next section.

**Note:** The next three pages contain Table 3: Comparison of the two media using the evaluation model.



*Table 3: Comparison of the two media using the evaluation model*

Areas to be evaluated within System Acceptability	Hard Copy of Syllabus	Hypermedia copy of Syllabus	Given or need research
<b>Social acceptability</b>			
medium anxiety	The medium of printed matter has been with us too long to create any significant anxiety for teachers.	Resistance and anxiety towards innovation and especially towards new technology are a major concern in the acceptance of this new form of syllabus.	Research required
gender and age	Teachers of both genders and all ages are familiar with the use of hard copy material	The literature does report that gender and age have an effect on how technology is viewed and used.	Research required
credibility	The print medium has high credibility as we have traditionally placed more credibility on written than on oral or electronic material.	Information stored electronically seems to have a lower credibility, thus the desire to have a hard copy of the information that is stored on disk.	Research required
cultural and social norms	The print medium is the current means of transferring information in our society.	Cultural and social norms of this very new medium have yet to be established. In certain areas, eg libraries, it is beginning to be used.	Research required
<b>Practical acceptability</b>			
complexity of medium	The complexity of the hard copy will be dependent on the nature of the content and presentation.	Once the user is familiar with it, the hypermedia copy has the potential to lower the complexity of the content due to its ability to randomly access information.	Hypermedia superior
cost	Developmental cost would be similar to the hypermedia copy.	Developmental cost would be similar to the hard copy. However the ease of editing and updating should make it more cost efficient.	Hypermedia superior
portability	Small amounts of material are highly portable. However as the amount of material increases, its portability will quickly drop.	With the constant decrease in price and weight of the necessary hardware, its availability becomes less of a problem. As the document increases in size, so does its portability in hypermedia form.	Hypermedia superior
compatibility	The printed version is highly compatible, as this is the traditional medium of transferring information.	This new medium's compatibility will be largely dependent on its social acceptability.	No real difference expected

storage capacity	This media can only store print and graphics and has poor storage capacity when compared with electronic storage.	This media can store all other types of media and has a very high storage capacity.	Hypermedia superior
reliability	After publication the hard copy is difficult to correct if errors are found or the material needs to be updated. Updating is not very cost effective.	The hypermedia document is easy to correct if errors are found after publication. Updating is very cost effective.	Hypermedia superior
<b>USEFULNESS</b>			
Utility	The hard copy does contain the necessary information. However the collection and use of related information may be difficult and time consuming.	Not only does it contain the necessary information but related information is provided in a form that is practically accessible. Whether teachers find this useful is not known.	Research required
Usability*	<b>Existing Ring Folders</b>	<b>Prototype</b>	
easy to learn how to use	As the structure of information presentation is very simple, it is easy to learn to use.	The GUI has to be designed to be easy to learn.	Research required
efficient to use	As the hard copy occupies two large ring folders it is not efficient to use.	The hypermedia copy allows random access to all the information seamlessly. The level of access will depend on the user's experience.	Research required
easy to remember	Methods of use are easy to remember.	Methods of use are easy to remember.	No real difference expected
few errors	Errors will often be made trying to obtain the correct page as there is no index or table of contents with the hard copy. These could be added, but it is difficult to cover all possible searches.	Due to the design of the GUI the users always know where they are and the next required page is only two to three mouse clicks away.	Hypermedia superior
subjectively pleasing	The two large ring folders are not subjectively pleasing because their size is off-putting and they are difficult to transport.	The GUI is designed to be subjectively pleasing. It is easy to transport, when hardware is available.	Research required
ease of updating	Being presented in ring folders it is possible to update. However the logistics make it an expensive and time consuming proposition.	Being in electronic form, it allows for cost effectiveness and logistically feasible updating.	Hypermedia superior

user assistance	Hard copy documents of curriculum often contain a limited table of contents and no index.	A number of levels of assistance are offered to the user, including the ones offered by the hard copy. All of these are only a few mouse clicks away.	Hypermedia superior
record structure	The information is set out in a static and linear fashion, the ring folder does however allow the user to arrange them as they wish, however it again becomes static and linear.	Due to the nature of hypermedia the information is available nonsequentially.	Hypermedia superior
retrieval techniques	Hard copy documents of curriculum often contain a limited table of contents and no index.	The GUI allows the user to retrieve information in a number of different ways.	Hypermedia superior

\* When both hypermedia and hard copy are designed to the highest level of perfection, hypermedia can generally be shown to be better. Because of this, usability will be case specific. The syllabus referred to in this section is the WA Mathematics Syllabus.

## Specific Research Questions for this Study

This study has set out to address a subset of questions which follow from the general questions raised above and the comparison of the two media. It was fundamentally concerned with the likely acceptance of syllabus document dissemination through a hypermedia application. A number of the comparison questions associated with the model are prescribed, "obvious" or beyond the scope of the study and were therefore discarded. This was the case for the usability comparison questions, as they were dependent on the design quality and characteristics of whatever user interface was to be used, and the ones associated with practical acceptability.

The questions whose answers were not so obvious and were considered manageable, considering the constraints of this study were refined to six specific research questions this study set out to address. These questions are presented below, divided into the two components of the evaluation model relevant to the questions.

### Question 1 - Social Acceptability

- (a) Do teachers with positive attitudes towards computers show a higher likelihood of acceptance of this type of application?
- (b) To what extent is relevant computer experience and level of relevant computer knowledge related to the likely acceptance of this type of application?
- (c) Are the gender and / or age of teachers related to their likely acceptance of this type of application?

## Question 2 - Utility

- (a) Are teachers satisfied with the current syllabus documents in helping them produce teaching programs?
- (b) How do teachers currently use the mathematics syllabus documents and how often?
- (c) In what ways do teachers perceive that hypermedia technology can assist them in formulation of their teaching programmes and to create links with the syllabus and other sources of information?

## Methodology

Broadly viewed, the methodology used for this study could be termed descriptive applied research. Fuchs (1980) described the applied research method as the study of "issues which have a relationship to contemporary problems" (p 4) and descriptive applied research as the description of "what is" (p 6). The major concern of this type of research is the description of an issue as fully and carefully as possible. In this study the issues are, the current usage of the Western Australian Mathematics syllabus, and whether hypermedia as a software tool can aid teachers in accessing curriculum documents. The research questions were developed to focus on these issues.

Descriptive research is further subdivided into: survey, case studies, correlation and ex post facto (Fuchs, 1980, p 6). This study uses two types of descriptive research, survey and correlation methods. The survey method was used to collect the required data needed from teachers. The correlation method was used to determine what, if any, are the relationships between the responses to the questions asked in the survey.

Survey research (Fraenkel and Wallen, 1990) has three major characteristics:

1. Information is collected from a sample in order to *describe* some aspect or characteristics (such as abilities, opinions, attitudes, beliefs, and/or knowledge) of the population.
2. Asking questions is the main way of gathering this information. The answers from the sample constitute the data for the study.
3. A sample is used rather than the whole population.

Fraenkel and Wallen (1990) describe correlational research as the degree to which two or more quantitative variables are related, and it does so by use of a correlational coefficient. Since this study set out to both collect information and look at the relationship between variables, based on the responses to the questions, it was appropriate to combine the two methods of descriptive research described above, the survey and the correlation.

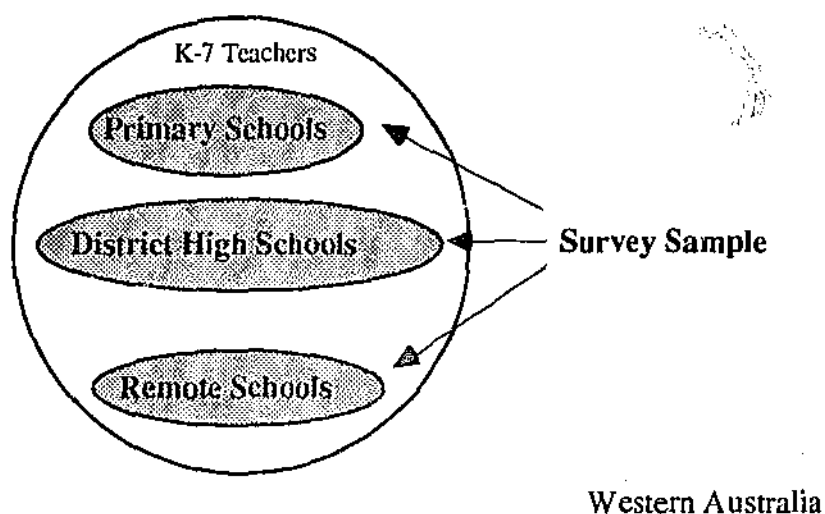
## Description of Samples

### Introduction

The target population of this study comprised all K-7 teachers using the Western Australia Mathematics syllabus within Western Australia. Independent schools were not included as they are not required to follow the Western Australia Mathematics syllabus. Three samples were selected to survey to be as large and as representative of the population as possible, given the resources available.

The three survey samples were teachers from: Primary Schools, both country and city, District High Schools that include a primary section and Remote Schools, consisting

mainly of Aboriginal community schools. The three samples of teachers were randomly selected to be surveyed from these three distinct sectors of the Western Australian K-7 primary teachers in government schools (see figure 6).



*Figure 6: The population and groups used in this study.*

## **Selection of Survey Samples**

These samples were randomly selected from the target population with an intention of maintaining the proportional balance in both gender and grade level. The whole population was divided into three sub-populations: Primary Schools, both urban and country, District High Schools with primary sections and Remote Schools (see Table 4).

Keeping as close to the population gender proportions as possible, teachers within each sample were randomly selected and stratified into three groups to obtain a spread of the grades taught. The three groups were: grades 1 to 3, 4 to 5 and 6 to 7. At each school where staff had been selected, the principal was sent copies of the survey with a covering letter asking him or her to select staff members who best fitted the criteria, or

failing this, any other staff member, except the computer co-ordinator. The survey was sent out to 276 teachers.

*Table 4: Primary Teacher Distribution by gender within the target population*

Distribution of Primary teachers	Primary Urban	District High	Remote Primary	Total
number of teachers	7,511	677	101	8,322
Number of surveys sent	200	50	26	276
% Males	26	23	38	26
% Females	74	77	63	74

## Description of Instrument and Data Collection

The instrument used in this survey was evaluated by having a number of computer education staff at Edith Cowan University complete and comment on the instrument.

The instrument consisted of five parts:

Part A - Personal details: including information on age, gender, relevant computing experience.

Part B - Computer Attitude Scale

- a) Computer Anxiety
- b) Computer Confidence
- c) Computer Liking

Part C - Questions on frequency and manner of use of the WA Mathematics syllabus.

Part D - Questions on computer experience and use both in and outside the classroom.



Part E - Questions on likely acceptance and usefulness of this type of application.

The data for the survey samples were collected by using a mailed questionnaire. This consisted of questions designed to collect data on the views and impressions of teachers on the social acceptability and utility of the present hard copy and possible use of a hypermedia copy. It was recognised that reasonable validity would be difficult to achieve with regard to questions on the utility of the hypermedia copy, as most teachers would be unfamiliar with this type of material. This was overcome to some extent by including within the questionnaire description of a prototype and how it would work. Their views about this new medium, partly based on this description, proved to be useful in this study.

The survey was sent out to urban and country primary schools, district high schools and remote schools within Western Australia (see Appendix 3). They were sent out late in third term 1992 with a covering letter explaining the aims of the survey and asking for their help. A return-by date was set six weeks after the last letters were sent out. A reminder was sent out ten weeks later and resulted in further responses.

The first three research questions concerned the effects of medium anxiety and of gender and age variables on the social acceptability of hypermedia. Due to limitations of time and that hypermedia is a sub-class of computer software, it was considered appropriate to initially look at the social acceptability of computers in general. The term anxiety was broadened to include computer attitudes, for as Massoud (1991, p 270) points out "the existence of computer anxiety is often based on computer attitudes".

***The Computer Attitude Scale (CAS)***

The *Computer Attitude Scale (CAS)*, designed by Loyd and Gressard (1984), is an instrument that measures attitudes toward learning and using computers. This instrument gives a total score and scores on three subscales. Three subscales of the

Computer Attitude Scale are: 1) *computer anxiety*, consisting of computer anxiety towards or fear of computers or of learning to use computers; 2) *computer confidence*, relating to confidence in the ability to learn about or use computers; and 3) *computer liking*, meaning enjoyment or liking of computers. Each subscale consists of ten items and presents positively and negatively worded statements such as "computers make me feel uneasy and confused" and "computers do not scare me at all". The instrument employs a four-point scale in which the participants indicate their feelings by selecting only one of the four choices. It does not include a neutral choice. Alpha reliability coefficients reported for the instrument were .78, .82, .75, and .91 (Massoud, 1990), for the Computer Anxiety, Computer Confidence, Computer Liking subscales and the Total Scores, respectively.

Item responses were coded so that a higher score indicated a high degree of liking or confidence and a higher degree of anxiety. The three subscale scores, Computer Anxiety, Computer Confidence, and Computer Liking, were obtained by summing the recorded items on the respective subscales. I reversed the anxiety scores so that a high score indicated a low degree of anxiety or a higher affinity towards computers before calculating the total score. The total score is the sum of the three subscale scores with the anxiety subscale score being reversed to make it an affinity score. A high score on any of the subscales or on the total scale indicated that the respondent had a positive attitude towards using or learning about computers.

### ***Measure of Acceptability of the System***

A measure of likely acceptance of this type of application was obtained from survey responses to Part E question (a) and (b) of the survey questionnaire which first gave a brief explanation of the advantages of having the syllabus available in a hypermedia form. These questions asked them to circle one of four responses (never, sometimes, often, always) to the questions: '(a) If you had access at *school* to this type of software

would you use it?' and '(b) was the same, except it replaced *school* with *home*'. If the response was often or always for either *school* or *home* use then it was recorded as **likely** acceptance of this type of application. If the response was never or sometimes for both *school* or *home* use, then it was recorded as **unlikely** to accept this type of application.

## Data Sources Related to Research Questions

Table 5 shows the way in which the information gathered from the survey is related to the research questions for the study. These data sources allowed results to be triangulated where possible, to improve the validity of the overall results.

Table 5: Relationship between Survey and Research Questions

Survey							
Research Questions	Part A	Part B - Computer Attitude Scale			Part C	Part D	Part E
		Anxiety	Confidence	Liking			
<b>1</b>	<b>Social Acceptability</b>						
<b>a</b>		√	√	√		√	a,b
<b>b</b>						√	a,b
<b>c</b>	√	√	√	√			a,b
<b>2</b>	<b>Utility</b>						
<b>a</b>					√		
<b>b</b>					√		
<b>c</b>							√

notes: √ = All of data source used for question.

Where only part of data source is used a letter is used to denote the relevant questions.

# **Chapter Four**

## **Results and Data Analysis**

### **Introduction**

The data analysed and presented in this chapter resulted from responses from the three survey samples and were mainly from the Primary School survey sample. The data were analysed using the computer software: StatView II, Microsoft Excel V4 and SPSS on a Macintosh microcomputer.

### **Survey Samples**

#### **The Samples**

The number of questionnaires sent out by letter to each survey sample, the number of replies initially received, the number received from the follow-up letter and totals are shown in Table 6. The small number of replies from Remote Primary and District High Schools makes it difficult to draw reliable conclusions from these results. However, they were shown as a guide to possible trends and as a comparison with the Primary Schools results. The Primary Schools response, represented 58 percent of the selected group and numbered 117 replies and as such is high enough to allow meaningful analysis of the data.

*Table 6: Number of respondents to Survey*

Samples	Letters sent out	Initial Replies	Reminder Replies	Total Replies	Percentage of sample	Percentage of population
Primary Schools	200	91	26	117	58%	1.5%
District High Schools	50	16	7	23	46%	3.4%
Remote Primary Schools	26	13	5	18	69%	18.0%
total	276					

From the data supplied by the Western Australian Ministry of Education, I was able to calculate the number of males and females for each of the sub-populations (this percentage and that obtained from the samples are shown in Table 7). This shows that the sampling procedures used gave a reasonable representation of the population, in terms of gender distribution. The samples could not be checked with the population, on the age of teachers or the number of years of teaching as this information was not available from the Ministry.

*Table 7: Percentage of males/females in each sample group compared with population as a whole*

Gender	Remote Schools n=17		District High Schools n=23		Primary Schools n=114	
	Sample	Population	Sample	Population	Sample	Population
males %	35	38	22	23	23	26
females %	65	62	78	77	77	74

## Reliability of Computer Attitude Scale

The alpha reliability coefficients of each of the subscales of the Computer Attitude Scale (CAS) were calculated and compared with other studies which have used this instrument (see Tables 8 and 9). The coefficients compare favourably with those of Massoud (1990) and Loyd and Gressard (1984).

**Table 8: Subscales of CAS - Alpha reliabilities for this study given by samples**

Sample	Sample size	Anxiety $\alpha$	Confidence $\alpha$	Liking $\alpha$
Primary Schools	115	.92	.91	.92
Remote Primary Schools	18	.91	.88	.91
District High Schools	23	.91	.89	.91
total	156	.92	.91	.92

**Table 9: Comparison of alpha reliability of CAS this study with other studies**

Scales	This study (1992)	$\alpha$ coefficients	
		Massoud (1990)	Loyd and Gressard (1984)
Computer Anxiety	.92	.79	.86
Computer Confidence	.91	.83	.91
Computer Liking	.92	.75	.91
Computer Attitude Scale	.96	.91	.95

### Likely acceptance of this type of application

The meaning and measurement of *acceptance* of this type of application were explained in the previous chapter. The likelihood of acceptance of this type of application as a percentage for each sample is shown in Table 10. A chi-square ( $\chi^2$ ) test was carried out assuming that no difference would be found between likely and unlikely acceptance of this type of application. The  $\chi^2$  test showed that the differences between likely and unlikely acceptance were statistically significant at the 0.001 level. The results thus seem to indicate that in each of the sample groups more teachers were likely to accept this type of application than not. For the remainder of the analysis of data an acceptance rate of 70% was assumed.

**Table 10: Sample percentage of likely and unlikely acceptance of this type of application**

Sample Group	% likely to accept	% unlikely to accept	$\chi^2$
Primary Schools (n=116)	70	30	16*
District High Schools (n= 23)	70	30	16*
Remote Schools (n= 17)	76	23	28*

\* Significant at the 0.001 level

## Results Related to Research Questions

### Research Question 1 (a)

*Do teachers with positive attitudes towards computers show a higher likelihood of acceptance of this type of application?*

A measure of the attitudes towards computers that teachers hold was obtained from the Computer Attitude Scale (CAS). This is a Likert-type instrument consisting of 30 items on a scale of one to four, giving a total score on a 120 point scale, where a score of 75 would indicate a neutral attitude towards computers. For this study, using this CAS measure three groups were identified by considering a person's score out of 120. A score less than 75 was called a *negative or neutral* attitude towards computers. A score between 76 and 90 was called a *positive* attitude towards computers, while a score greater than 90 was called a *very positive* attitude.

The measure of the likelihood of acceptance of this type of application was obtained by combining the responses to Section E parts (a) and (b). For more on this measure see explanation in previous chapter.

A  $\chi^2$  test was carried out, assuming that no difference would be found between the attitude of the group's likely acceptance of this type of application and the overall likely acceptance rate for the sample of 70 percent. The  $\chi^2$  results show that the differences between the overall likely acceptance rate for the sample and that of each of the groups were statistically significant at the 0.02 level and are shown in Table 11 for the Primary School sample.

*Table 11: Primary Schools sample CAS score related to likely acceptance*

CAS	score	No	% of total sample	% of group likely to accept	$\chi^2$
very positive	> 90	64	55	86	
positive	≤ 90	35	30	63	
negative or neutral	≤ 75	17	15	24	
total		116	100	70	7.85*

\* Significant at 0.02 level

The Primary Schools results tend to indicate that as teachers' attitudes towards computers, as measured by the CAS, tend to be more positive, so does their likely acceptance of this type of application. The *very positive* group of about half the sample indicated a likelihood of over 80 percent of acceptance of this type of application. The results also show that only about 15 percent of the sampled teachers held a negative or neutral attitude towards computers. These teachers were very unlikely to try this type of application, with only 24 percent of these indicating that they were likely to accept this type of application.

Another measure of attitude towards computers was obtained from the second component of Part D question four. This followed asking teachers 'Do you use a computer for personal work?' with and if not 'Would you like to?'. The required response was yes or no. Of the teachers who did not use a computer for personal use, only 25% (that is, 12% of the total sample), indicated that they would not like to use a computer for personal work (see Figure 12). This figure of 12% not wishing to use computers for personal use is close to the 15% who showed a negative or neutral attitude towards computers on the CAS scale (see Figure 11). On comparing these two groups it was found that about 57 percent were the same individuals.

A  $\chi^2$  test was carried out assuming that no difference would be found between this subgroup's likely acceptance of this type of application and the overall likely acceptance rate of 70 percent for the whole sample. The  $\chi^2$  test was not significant (see Table 12).



*Table 12: Teachers not using computers for personal use compared with likely acceptance of this type of application (Primary School sample) n= 54*

Grouped by response to: D4	% of total sample	% of group likely to accept	$\chi^2$
<b>Do you use a computer for personal work?</b>			
if no would you like to: n=57			
yes	75	66	0.92
no	25	43	

The relationship between the attitude towards computers that teachers hold and their likely acceptance of this type of application was also investigated by grouping according to acceptance. This relationship is shown in Table 13.

A one-tail *t*-test was carried out on the CAS means for each sample with the null hypothesis being assumed. This hypothesis states that no actual difference exists between the CAS means for the two groups. The null hypothesis was rejected for the three samples at the 0.05 level (see Table 13 for Primary Schools sample). Thus it can be assumed that there is an actual difference between the CAS means for likely and unlikely acceptance of this type of application.

Those teachers who were likely to accept this type of application were also likely to have a more positive attitude towards computers than those unlikely to accept this type of application. It must be remembered that the CAS score is the sum of three subscales of computer anxiety, confidence and liking. Procedures will need to be looked at that are likely to increase teachers favourable attitude towards computers for the 30 percent that were unlikely to use this type of application. The other two samples, Remote and District High Schools showed a similar result.

*Table 13: Primary Schools teachers' likelihood of acceptance of this type of application as related to CAS scores*

Acceptance	No	%	CAS mean	SD	<i>t</i>
Likely	81	70	96.3	13.6	
Unlikely	35	30	83.2	14.6	
total	116	100	92.4	15.1	1.670*
Pooled Variance				3.5	

\* Significant at 0.05 level

## Research Question 1 (b)

*To what extent is relevant computer experience and level of computer relevant knowledge related to the likely acceptance of this type of application?*

In the three samples, only two teachers, both from the Primary Schools sample, indicated that they had not used a computer before. Measures of *relevant computer experience* and *computer (software) relevant knowledge* were obtained by an analysis of five questions in the Survey (see Table 14). Three measures of *relevant computer experience* were obtained using data from Part D questions two, four and five, of the survey questionnaire. One measure of *computer relevant knowledge* was obtained by combining data from Part D questions seven and ten.

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*Table 14: Questions related to Previous Computer Experience and Computer Relevant Knowledge*

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### Questions from the survey questionnaire

#### Measures of Previous Computer Experience

- D 2      competence in use of computers (scale 1 to 4)
- D 4      personal use of computers (yes/no) If no would you like to? (yes/no)
- D 5      use of computer for school related work (scale 1-5)

#### Measure of Computer Relevant Knowledge

- D7      Have you attended a course on how to use a computer, since 1988. (yes/no)
  - D10     Have you used ... (yes/no)
- 

A  $\chi^2$  test was carried out on each of the measurements assuming that no difference would be found between the likely acceptance of this type of application by each group and the overall likely acceptance rate of 70 percent for the whole sample.

## Measures of Previous Computer Experience

### *Teachers' self rating of relevant computer experience*

The first measure of relevant computer experience was obtained from Part D question two. It asked the teachers 'How would you rate your competence at using a computer?' on a scale of one to four representing very competent to not at all competent. This defined four groups; very competent, quite competent, minimally competent and not at all competent.

A  $\chi^2$  test was then used to compare the percentage of each group likely to accept this type of application with the 70 percent acceptance for the whole sample. Using this measure of competence at using a computer the  $\chi^2$  test showed no significant difference on the likely acceptance of this type of application.

This scale was then modified by combining very and quite competent into *competent*, and minimally and not at all competent into *not competent*. The modified scale was considered appropriate as the study was interested in teachers' competence at using a computer and the data showed that most respondents considered themselves either quite or minimally competent, while very few in the sample considered themselves very or not at all competent. The combining of the scales into competent and not competent did not alter the measurement. The  $\chi^2$  test was again not significant (see Table 15).

It is interesting that just under half the teachers sampled considered themselves not competent at using computers. Considering that the majority of teachers now have access to computers this perceived lack of competence must be considered a major limiting factor when considering how teachers use computers professionally. This low rating would seem to indicate that either teachers were rating themselves harshly or more likely that a great deal more inservicing is needed to lift up the competence level of primary school teachers.

*Table 15: Primary Schools competence compared with likely acceptance of this type of application n= 112*

Grouped by response to: D2	% of total sample	% of group likely to accept	$\chi^2$
<b>Competence at using computer</b>			
very competent	8	89	
quite competent	49	78	
<b>competent</b>	<b>57</b>	<b>80</b>	
minimally competent	36	65	
not at all competent	7	38	
<b>not competent</b>	<b>43</b>	<b>60</b>	<b>1.43</b>
<b>total</b>	<b>100</b>	<b>71.4</b>	<b>2.25</b>

*The use of computer for personal work*

The second measure of relevant computer use was obtained from Part D question four. It asked the teachers 'Do you use a computer for personal work?' This measure was grouped according to the response yes/no. A  $\chi^2$  test was carried out assuming no difference would be found between the likely acceptance of this type of application by each group and the overall likely acceptance rate of 70 percent for the whole sample. The  $\chi^2$  test showed that the difference between the overall likely acceptance rate and that of the groups is statistically significant at the 0.10 level for the Primary School sample (see Table 16).

*Table 16: Use of a computer for personal work compared with likely acceptance of this type of application (Primary School sample) n=112*

Grouped by response to: D4	% of total sample	% of group likely to accept	$\chi^2$
<b>Do you use a computer for personal work?</b>			
yes	48	81	
no	52	60	1.845*

\* Significant at the 0.10 level

From this result it would appear that the use of a computer for personal work is an indicator of likely acceptance of this type of application. While only about half the teachers sampled declared that they use a computer for personal work, 81 percent of these said they were likely to accept this type of application. The reasons for not using a computer for personal use were not investigated in this study, but it is a possibility that as access to computers at home and school improves, teachers' use of computers

for personal use will increase. This would then increase their likely acceptance of curriculum documents in hypermedia form.

### *Use of computer for school related activities*

The third measure of relevant computer experience was obtained from Part D question five. It asked the teachers 'How often do you use a computer for school related activities?' on a scale of one to five from most days to never. This defined five groups; most days, several times a week, several times a month, several times a year and never. Before this measure, 'use of computers for school related activities' could be used it was necessary to know if teachers had access to computers at school.

Teachers' access to computers at school was measured in Part A question three 'How many computers do staff have access to?'. All teachers in the Remote and District High Schools samples indicated that they had access to computers at schools. Only three teachers in the Primary School sample indicated that they did not have access to computers at school. Although the ease and amount of access were not measured, computer access was available to the majority of teachers and thus would not substantially affect their use of computers for school related activities.

The  $\chi^2$  test showed that there was no significant difference on the likely acceptance of this type of application by each group and the overall likely acceptance of this type of application based on the amount of use of computers at school (see Table 17).

When the scale was modified by combining most days and several times a week into *frequent* and several times a month, several times a year and never into *infrequent*, the  $\chi^2$  test was again not significant. The modified scale was considered appropriate as the study was interested in the frequency of use of computers by teachers for school related activities and the modified scale did not alter this measurement.

*Table 17: Use of computers for school related activities compared with likely acceptance (Primary School sample) n=114*

Grouped by response to: D5 use a computer for school related activities?	% of total sample	% of group likely to accept	$\chi^2$
most days	24	85	
several times a week	33	79	
<b>frequent</b>	<b>57</b>	<b>82</b>	
several times a month	18	57	
several times a year	18	67	
never	7	29	
<b>infrequent</b>	<b>53</b>	<b>57</b>	<b>2.34</b>
%	100	71	3.64

The Primary Schools sample result indicated that the use of computers by teachers for school related activity is not likely to affect their acceptance of this type of application. However, the result did show a low overall usage of computers by teachers for school related activities. Only 24% of the teachers sampled indicated that they use a computer most days. This result could be interpreted, assuming access is not a problem, to be indicating that the available software applications were not fulfilling the needs of the teachers sampled or that they were unaware of the software that is available.

#### *Measure of Computer relevant knowledge*

A measure of the teachers' level of *computer (software) relevant knowledge* was obtained from the responses to Part D questions seven and ten that required a yes/no response (see Figure 18). Question seven asked teachers if they had attended a course on how to use a computer, since 1988. Question ten consisted of nine parts asking, "Have you used..." covering areas such as word processing, database and CD-ROM. The responses to these questions were used to obtain a measure of the experience that teachers have had of different computer applications.

- ① The two responses in question seven related to hypermedia use were taken out and the results from the remaining questions were added together, with yes = 1 and no = 0. A score between five and seven was classified as *competent and experienced*, a score between four and three was classified as *developing expertise* and a score between zero

and two was classified as *novice*. A yes response to Part D seven, 'Have you attended a course on how to use a computer, since 1988?', moved the respondent from the *novice* group into the developing *expertise* group.

A  $\chi^2$  test was carried out assuming that no difference would be found between the likely acceptance of this type of application by each group and the overall likely acceptance rate of 70 percent for the whole sample (see Table 18). The  $\chi^2$  of 3.368 was not significant.

*Table 18: Computer relevant knowledge compared with likely acceptance of this type of application n=114*

Grouped by response to: computer relevant knowledge	% of total sample	% of group likely to accept	$\chi^2$
Competent and Experienced	25	93	3.368
Developing Expertise	19	59	
Novice	55	65	

The result appears to indicate that using this measure of computer relevant knowledge, it has no effect on the likely acceptance of this type of application. The data do show that about half the teachers sampled were found to be novice users of computers. This is about the same percentage that indicated that they do not use a computer for personal work.

### **Research Question 1 (c)**

*Are the gender and/or age of teachers related to their likely acceptance of this type of application?*

Data on gender and age groups of teachers were obtained from part A, questions two and three. Once again a measure of their likely acceptance of this type of application was obtained from Part E, (a) and (b) and expressed as likely or unlikely to accept this type of application (see earlier introduction). Each sample's gender distribution closely

followed that of the sample populations. The age range was divided into four groups of three ten year intervals, starting at 21 years old and finishing with over 51 years old. Data on the population age range was not available and no comparison was thus possible with the samples.

A  $\chi^2$  test was carried out assuming that no difference would be found between the gender groups' likely acceptance of this type of application and the overall likely acceptance rate of 70 percent for the whole sample. A further similar test was used to consider the age groups in the same way. The results are shown in Tables 19 and 20.

*Table 19: Gender of sample compared with use of this type of application (Primary School sample) n=114*

Gender	% of total sample	% of group likely to accept	$\chi^2$
male	23	73	0.275
female	77	68	
total	100	71	

*Table 20: Age range compared to likely acceptance of this type of application (Primary School sample) n=115*

Age Range	% of total sample	% of group likely to accept	$\chi^2$
21-30	30	77	0.558
31-40	30	66	
41-50	33	66	
>51	7	86	
total	100	70	

The gender and age results for the three samples seemed to show that the gender and age of teachers has little effect on their likely acceptance of this type of application. The gender results may have been distorted by the small number of males in the samples as the literature on gender attitude towards technology would lead one to expect males to have a higher acceptance rate. The literature also has tended to find that older people were more resistant to new technology than younger people. In contrast



these results indicated that for this sample of teachers neither gender nor age were likely to affect their acceptance of this type of application.

## Research Question 2 (a)

*Are teachers satisfied with the current syllabus documents in helping them produce teaching programs?*

Three measures of *satisfaction* with the current syllabus were obtained from the survey. They were, ease of use of current syllabus, potential for improvement of presentation of current syllabus and whether the previous syllabus was better (see Table 21).

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*Table 21: Questions related to satisfaction with current syllabus*

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C 2	Do you find the WA Mathematics syllabus an easy document to use? (yes/no)
C 4	Could the presentation be improved?' yes/no
C 5	Did you find the old WA mathematics syllabus better?' yes/no

---

The Primary School sample was grouped according to response to each question (see Table 22). For each question a  $\chi^2$  test was used to test for differences assuming a null hypothesis of no difference between responses. The results were significant for the three samples, Remote, District High and Primary Schools at the 0.001 level and showed a similar trend. Except for the question 'Can presentation be improved?' which showed that for the Primary School sample teachers were evenly divided (see Table 22). The other two samples were divided on this question, with less than 50 percent of the District High Schools sample and more than 50 percent of the Remote Schools sample stating that it could be improved.

*Table 22: Satisfaction with syllabus (Primary School sample)*

Q	C2 Is easy to use? n=111	C4 Can presentation be improved? n=109	C5 Is old syllabus better? n=105
% yes	82	57	23
% no	18	43	77
$\chi^2$	41*	1.96	29*

\*Significant at 0.001 level

These results seemed to indicate that although the majority in the three samples found the syllabus an easy document to use, over 50 percent of both the Primary School and Remote School sample felt that the syllabus presentation could be improved. This is a high level of dissatisfaction with the presentation or lack of usefulness of a document that is in frequent use. This result seems to contradict to some extent the high score for ease of use. Only a quarter of the teachers sampled considered the old syllabus better. This may indicate that the new syllabus is appreciated by more users than the old one, but the comments also indicated that many of the newer teachers had not used the old syllabus. While the new document may be an improvement over the old one, its usefulness could well still be poor.

The evaluation model developed for this project divided usability into a number of sub-parts; easy to learn, efficient to use, easy to remember, subjectively pleasing, record structure and retrieval techniques. The comments of the teachers who answered yes to 'could the presentation be improved' are listed in Appendix 4. Most commented that they found the record structure and retrieval techniques a problem. One teacher declared 'plenty of valuable information, but difficult to access, not teacher friendly.' Another said, 'It's a pain in the neck because it's all over the place and it is not very easy to find particular components.'

The inadequacy of the record structure and retrieval techniques may also contribute to its lack of usability in terms of the other sub-parts of usability: easy to learn, efficient to use, easy to remember and subjectively pleasing. Even a teacher reporting that the

document is easy to use commented 'however, it is annoying in that there is no list of the concepts covered or where you go to find them (no page numbers), so you have to flick through the whole thing to find what you want.'

The large size of the document, two large A4 ring folders obviously contributed to this problem of record structure and retrieval techniques. Six teachers commented directly on the size. Typical comments were, 'it's a very bulky item and awkward to 'take home' or carry from place to place' and 'too bulky, confusing, too much information.' Many of these problems can be readily addressed by the proposed computer based hypermedia syllabus documents.

### **Research Question 2 (b)**

*How do teachers currently use the mathematics syllabus documents and how often?*

Data on how teachers currently use the syllabus document was obtained from Part C question three 'What do you use the syllabus for?'. The majority of teachers in the three sample groups commented that they used the syllabus for planning, programming and lesson preparation. Other uses of the syllabus ranged from information, checking, ideas and activities. The comments, when grouped under the responses to 'How often do you use the syllabus?', indicated that the teachers who use the syllabus weekly, tended to use it more for planning, programming and lesson preparation, while teachers using the syllabus less frequently tended to use it more often for checking, information and activities.

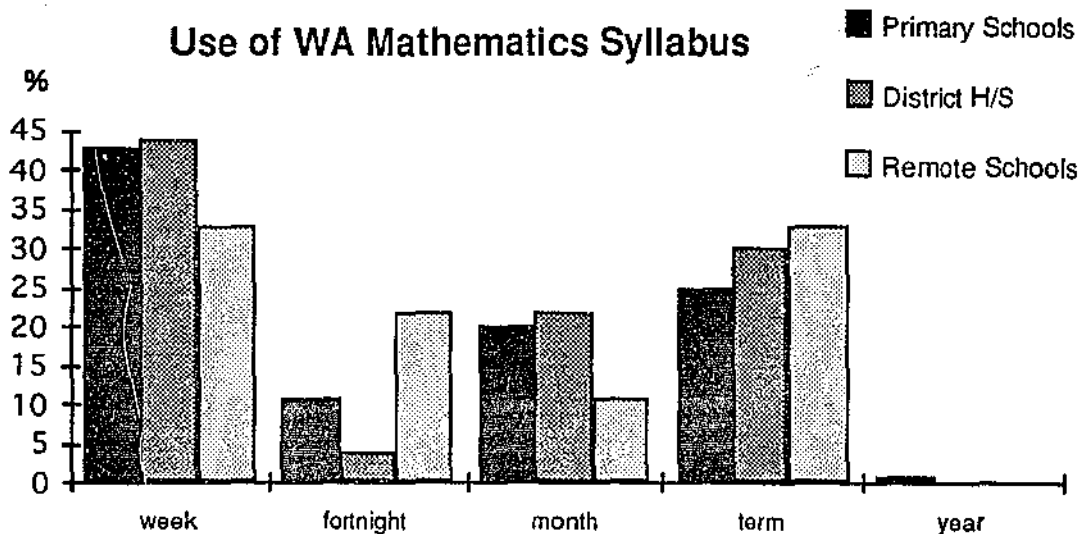
Data on how often the syllabus was used was obtained from Part C question one 'How often do you use the WA Mathematics syllabus (please circle)? Once a - week, fortnight, month, term, year.' The term and year groups were combined as only one

teacher indicated using the syllabus only once a year. The results for the Primary Schools sample are shown in Table 23. A  $\chi^2$  test was carried out assuming that no difference would be found between the groups' likely acceptance of this type of application and the overall likely acceptance rate of 70 percent (see Table 23).

*Table 23: Use of syllabus compared with likely acceptance (Primary School sample)*

Part C Q1 use of the WA Mathematics Syllabus?	% of total sample	% of group likely to accept	$\chi^2$
weekly	43	73	
fortnightly	11	58	
monthly	20	82	
term / year	26	65	
total	100	70%	0.776

The frequency of syllabus use by teachers in the Primary School sample had no effect on their likely acceptance of this type of application. The other two samples showed a similar result. The three samples showed a similar trend in usage, as the graph in Figure 7 shows. Over 40 percent of teachers in the Primary and District High School samples use the syllabus on a weekly basis.



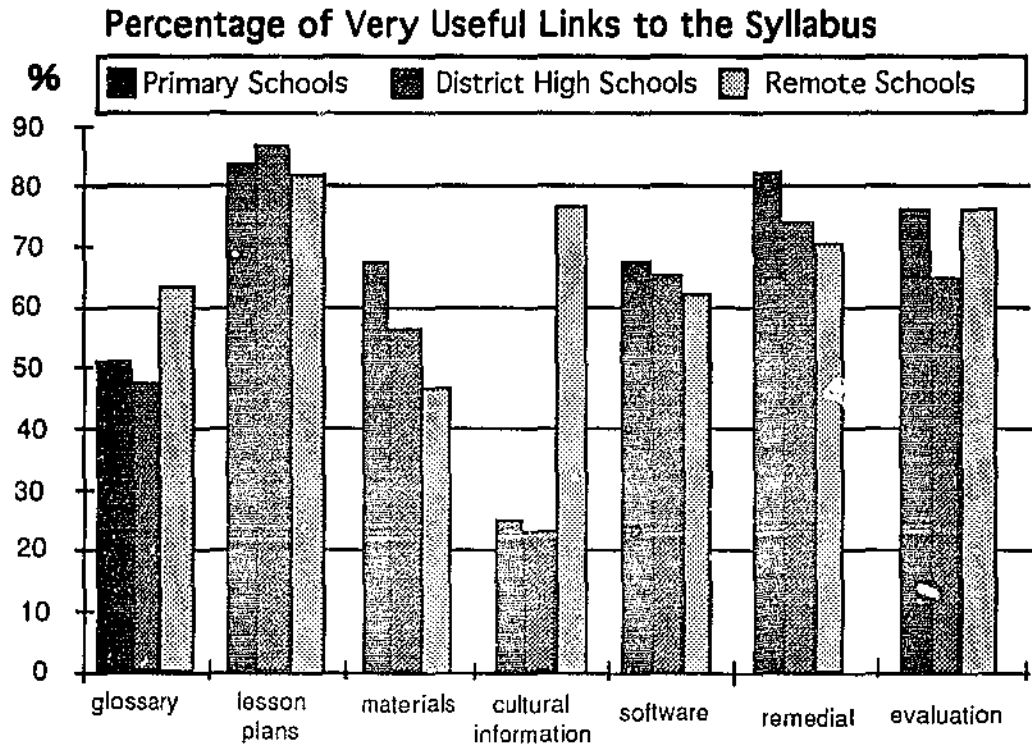
*Figure 7: Use of the WA Mathematics Syllabus by the three sample groups*

## Research Question 2 (c)

*In what ways do teachers perceive that hypermedia technology can assist them in formulation of their teaching programmes and to create links with the syllabus and other sources of information?*

The data from research question two (a) 'Are teachers satisfied with the current syllabus documents in helping them produce teaching programs?' supply information on the usefulness of the present syllabus. Part E question (c) of the survey questionnaire supplies data on the second part of the question: can Hypermedia assist 'to create links with the syllabus and other sources of information?'. The question asked 'Do you think any of the following would be useful if presented on the computer screen and directly linked to the syllabus objectives by only clicking the mouse?' please tick very useful, useful or not useful. The results for the response *very useful* for the three survey samples are shown in Figure 8.

The replies to the survey questions on *ease of use* and *presentation improvement* of the current syllabus documents identified record structure, retrieval techniques and size as the major concerns of the teachers sampled (see Appendices 5 and 6). As one teacher commented, it is 'difficult to find relevant information quickly. Very bulky'. Many teachers commented that they would like the structure to be different, for example 'an index or contents at the beginning of each section', 'index to locate specific areas' and 'restructure within the three strands, to show progressive development of concepts, year level as a secondary sort level'. A hypermedia presentation of this document would be able to address these issues and thus would seem to be of greater usefulness than the present hard copy.



*Figure 8: Very useful links to the syllabus for the three samples*

The results show that the teachers sampled perceived a need to have easy access to materials they need when using the syllabus document. The majority in the three samples considered the idea of links between the syllabus and the lesson plans/ideas/concepts, remedial and enrichment material, evaluation ideas and materials and appropriate software to be very useful. Where knowledge of the students cultural background was considered important or relevant to the teacher, as is the case in Remote Schools, the response rose to 76 percent for the link to aboriginal and cultural information, from a low of 20 percent for the other two samples.

# Chapter Five

## Discussion and Conclusions

### Summary of Study

The study began by considering two problems associated with the present hard copy format of syllabus documents: the increasing rate of change in syllabus documents due in part to the increasing rate of change within society and how this material is presented, disseminated and implemented. These problems place a great burden on already overloaded teachers to keep up to date with curriculum materials and current teaching methods. The study was concerned with the possibility of using a new medium for presentation, hypermedia, a new tool for information handling to overcome some of the impediments of curriculum production, dissemination and implementation that are associated with the hard copy medium.

The study required the review of relevant literature in three fields: literature related to curriculum production, dissemination, implementation and evaluation; literature concerned with the history of information storage, transfer and presentation; finally, literature concerned with hypermedia (hypertext and multimedia), its development, implementation, evaluation and potential.

A number of questions were developed based on the model presented by Nielsen (1990) for evaluating system acceptability (see Figure 5). This model, although developed for evaluating traditional computer systems, was adapted for use in the comparison of the two media, that is hypermedia and print media. The study addressed two main areas

associated with this model of evaluation, social acceptability and utility. A number of comparison questions were developed to collect data on these two areas. Table 5 shows the relationship between survey and research questions.

## **Synthesis of Findings**

The findings were grouped according to the two areas investigated that were identified from the Nielsen evaluation model: social acceptability and utility.

### **Social Acceptability**

Social acceptability is concerned with social attitudes towards the product and although they are intangible they are very important if the product is to be accepted. The literature indicated that medium anxiety, gender and age are important aspects of social acceptability of computers and by inference, of this type of media presentation. Associated with these social attitudes is the credibility of the medium and how it fits with cultural and social norms. The hard copy does not face any of these social acceptability problems because this medium has been with us for so long that we have accepted it as natural.

In this study, medium anxiety is associated with resistance and anxiety towards innovation and especially towards new technology. The print medium presents no anxiety for teachers while the literature indicates that hypermedia may present a number of areas of anxiety. The results from this study showed that the likely medium anxiety of this type of application is low for the teachers sampled with 70 percent indicating that they were likely to accept this type of application. The results also



showed that the likely acceptance rate increased as the teachers' positive attitude towards computers increased, as measured by the Computer Attitude Scale.

Two further potential influences on likely acceptance of this type of application are previous experience and current usage of computers. Relevant computer experience was shown to be significant in two of the three measurements used in this study. When the teachers were asked to rate their own competence at using a computer, the results showed that when grouped into competent and not competent, that more teachers were likely to accept this type of application if they saw themselves as competent computer users. Time spent using a computer at school showed that teachers who frequently use them, at least several times a week, were more likely to accept this type of application.

The literature has often shown that gender and age affect the acceptance of innovation, especially that of technological innovation. The results in this study indicated that neither the gender nor the age of the teachers sampled affected the likely acceptance of this type of application. Although the sample size was adequate, the gender results may have been distorted by the small number of males in the samples. The results seemed also to be showing that acceptance by teachers of the computer as a tool is becoming widespread.

The credibility and the compatibility with cultural and social norms of hypermedia were not investigated as they were beyond the scope of this study. However, they are important and warrant study, as more and more information is being made available in the digital/electronic form. Information on these areas of social acceptability is also important for developing the user interface.

## Utility

Utility refers to the ability of the product to do what is needed or required. Both media can achieve this, however hypermedia does not only contain the necessary information but related information is provided in a form that is practical and easily accessible. The study investigated whether this enhanced utility would be considered useful. It found that the majority of teachers sampled, considered the ability to link the syllabus to lesson plans / ideas / concepts, remedial and enrichment material, evaluation ideas and materials and appropriate software, to be very useful. The study also found that the special needs of teachers such as teachers in Remote Schools could be met by this medium. This was shown by the majority of Remote Schools teachers indicating that they considered links to aboriginal / cultural information very useful.

The results of the survey do indicate that many of the problems associated with the hard copy of the Mathematics syllabus could be overcome by using a hypermedia version. The survey results showed that although a majority of the teachers sampled found the syllabus an easy document to use, about half the sample indicated that the syllabus could be improved. A hypermedia version could overcome many of the problems identified and carry out the improvements to the present hard copy identified by the teachers sampled. This includes ease of updating, user assistance, record structure and retrieval techniques.

The comments focused on the large size of the Mathematics syllabus (two full ring folders), the difficulty in accessing and finding the information, in cross referencing entries and in wanting to access the information differently from how it is presented. A hypermedia version of this document would overcome all these problems and add easy access to other related resources.

## **Limitations of the study**

In considering the limitations of this study it must be borne in mind that at present very few hypermedia documents exist for teacher use only. Hypermedia student educational material has only recently been introduced into schools and mainly with limited student access, usually in the library. However this is rapidly changing as the price of the hardware required to run hypermedia material continues to fall and more educational hypermedia material is becoming available. It is likely that over the next few years, teachers will become familiar with hypermedia material and its potential for both student and teacher use.

In the present study it was thus necessary to supply in the survey a brief description of what would be possible with a Mathematics syllabus supplied in a hypermedia format. The important questions of the likely acceptance of a hypermedia document version were asked and how they use and find the current hard copy document. This means that the study was only able to attempt to answer questions on teachers "likely acceptance" that does not mean their "actual acceptance" of this type of application. No study to investigate teachers' attitudes towards or use of hypermedia documents for teacher use only had been carried out before. It was therefore considered important to obtain knowledge of the attitude of the user group, in this case primary teachers, using the WA mathematics syllabus, before a complete hypermedia prototype is developed and evaluated.

## **Implications of study**

The findings of this study have implications for the production of new and existing curriculum material. A majority of the teachers sampled indicated that they were

willing to try a hypermedia version of the WA mathematics curriculum and by inference of any curriculum material. State Education Departments in Australia should thus seriously consider the trialing of this type of presentation. The production of prototypes will not be difficult as curriculum materials already exist in digital form and the conversion to a hypermedia format is not technically difficult. However the design of the interface and the types of materials to be linked with the syllabus must be done in consultation with the teachers going to use the hypermedia materials. Once recognised, the ease of updating and of accessing the material will be major selling points. The potential saving in the cost of paper alone could be enormous, as only what is needed will be printed out.

## **Recommendations for Further Research**

The limitations of this study mean that it is important that the findings be replicated by similar studies in other curriculum areas. However the study did show that the majority of teachers surveyed were highly agreeable to trying this new medium. Thus the next stage of research is to investigate whether this high agreeability is matched by actual usage of a hypermedia curriculum document. This will involve in part the comparison of hard copies with prototypes of curriculum hypermedia documents.

In light of the findings on utility obtained in this research, the proof-of-concept demonstration hypermedia document that was developed prior to this study (see Chapter One, the background to the study) should be modified. This modified prototype could then be used in the comparison of the two media. This comparison would initially take the form of short exercises carried out using both the hard copy and the prototype. During this initial investigation of the prototype, the user interface would need to be evaluated for its usability, to ensure that it is not hindering access to the information.

As the prototypes become more refined, the evaluation will need to be done in a number of situations of increasing complexity and finally, carried out in context, that is, an ecological evaluation. The importance of this is discussed by Lindgaard (1992).

## Conclusion

Hypermedia software both commercial and educational is growing rapidly. This study has investigated an area that has been neglected until now: the presentation of teacher only material such as syllabus and related resources in a hypermedia format. The study found that a majority of primary school teachers sampled were likely to accept a hypermedia version of the syllabus. This new medium holds the possibility for teachers to gain greater access to and control of curriculum information and related teaching resources.

Since the start of this study, a number of teacher-centred computer based curriculum materials have become available. The Longman Cheshire book company has produced a junior / middle secondary student science series with a teacher's guide on disk containing the equivalent of 500 pages of A4 text. The Australian Association Of Mathematics Teachers is producing Mathematical Bytes, a mathematics journal on disk. The New Horizons computer company has produced on disk the Maths Worksheet Generators Vol 1. This allows teachers to produce examples at the right level for the class or individual students.

The study showed that teachers were highly receptive to this change of presentation. What remains to be seen is whether the actual syllabus materials will become available in Hypermedia form, as this study is recommending. It would thus create dynamic links between the syllabus and information about educational materials, both commercial and public domain. As hypermedia becomes increasingly pervasive as a tool for traditional

tasks in our society, it will begin to change the tasks themselves. Hypermedia is not just an improved hard copy on the computer screen but allows the user to be both reader and author and to access all forms of information.

This high willingness of the teachers sampled to try this new form of information presentation has wider significance. Hypermedia is an example of a number of new tools that are computer or technology based, now becoming available to teachers. This study shows that an important threshold has been passed in the acceptance of these new tools. What remains to be investigated is what effects these new tools will have on traditional tasks when applied to them.

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# Appendices

## Appendix 1 User characteristics

In the design and development of the prototype certain assumptions have been made based on the user characteristics. The following relevant and specific user characteristics of primary school teachers, some of which may need to be verified, were used to develop and evaluate the prototype are listed below:

- *intelligent* :  
Assumed on the basis of having completed three years of tertiary education.
- *has computer naivety* :  
At present computer literacy training is normally offered as an elective in teacher education and has only been offered at school since the early 1980s.
- *has little time to learn* :  
Teachers are finding it difficult to manage under their present work load.
- *performs retrievals occasionally* :  
Teachers are not required to perform retrievals.
- *has antipathy towards computers* :  
This will need to be surveyed.
- *has no model of a database* :  
This knowledge is largely absent from the current primary school curriculum and from teacher education.
- *has good knowledge of information in database* :  
Yes, as the information is based on the syllabus documents.
- *has poor knowledge of data items names* :  
Teacher will not be aware of the need to be precise in entering items to be looked up.
- *a large proportion of teachers are women* :  
As at 1991, 74 percent of primary school teachers are women in WA.

## **Appendix 2 Sub-Questions associated with the General Research Question**

### **Question 1 - Social Acceptability**

- a) What are the user characteristics of the majority of users?
- b) To what extent is teacher resistance to change and use of technology likely to significantly hinder the efficient use of this type of application?
- c) Is the gender of the teacher likely to significantly influence the efficient use of this type of application?
- d) Is the age of the teacher likely to significantly influence the efficient use of this type of application?
- e) Is the view of information technology that the teacher holds, likely to significantly hinder the efficient use of this type of application?
- f) To what extent are previous experience and level of computer related knowledge likely to significantly influence the efficient use of this type of application?

### **Question 2 - Practical Acceptability**

- a) Is the hypermedia copy easier to understand and use than the hard copy?
- b) Is the 'general' hypermedia interface seen by the user to be consistent with their existing values, past experiences and needs?
- c) Is the hypermedia copy reliable?
- d) What are the differences in the production cost of the two forms of presentation?
- e) Is the portability of the hypermedia version an important consideration?

**Question 3 - Utility and Usability in general**

- a) How often do teachers use the present syllabus documents?
- b) How do teachers currently use the syllabus documents?
- c) Are teachers satisfied with the current syllabus documents in helping them produce high quality programs.
- d) Do teachers perceive that the ability of this new technology to create links with other sources of information will help them formulate their teaching program?
- e) Can new information technology assist teachers in accessing the syllabus?
- f) Will the ability to easily update and add information be considered of value by the teachers?
- h) Would teacher time be saved by using hypermedia as a means of curriculum information presentation?



## Appendix 3 Survey Questionnaire

**Teachers' use of  
the WA Mathematics syllabus  
and  
their use and attitude  
towards Computers**

**Dear Teacher**

I am seeking your assistance in collecting information on the use of the WA mathematics syllabus and the use and attitude of teachers towards computers. The long term objective of this research project is to computerise syllabus documents that will be far more efficient, easy to use and accessible than the present syllabus.

At present a prototype of a computer based version of the WA Mathematics syllabus has been developed (up to Stage 3) and is under evaluation. If you have access to a Macintosh computer with a hard disk and would like to be involved in the evaluation of the software, I would be pleased to supply the disk and evaluation form.

To assist you in returning the questionnaire I have supplied an addressed envelope.

Thank you for your assistance.

Alistair Campbell

c/o Paul Newhouse  
Computer Education  
Edith Cowan University  
2 Bradford Street  
Mount Lawley WA 6050

**Please return by the  
26 October 1992**

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### Part A

1. School: \_\_\_\_\_
2. How many computers do students have access to? \_\_\_\_\_
3. How many computers do staff have access to? \_\_\_\_\_
4. Does your school administration use computers? yes/no  
If yes are they used for more than word processing? yes/no
2. Gender: (circle)      M / F
3. Age range: (circle)      

21-30	31-40	41-50	51 >
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4. How long have you been teaching for? \_\_\_\_\_ years
5. Which grade level do you currently teach? (circle) 

K	1	2	3	4	5	6	7
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**Part B** - please answer the following by putting a cross mark (X) in either "strongly agree," "disagree," "agree," or "strongly disagree" column.

	strongly agree	agree	disagree	strongly disagree
1 Computers do not scare me at all.....				
2 I'm no good with computers.....				
3 I would like working with computers.....				
4 Working with a computer would make me very nervous.....				
5 Generally I would feel OK about trying a new problem on the computer.....				
6 The challenge of solving problems with computers does not appeal to me.....				
7 I do not feel threatened when others talk about computers.....				
8 I don't think I would do advanced computing work.....				
9 I think working with computers would be enjoyable and stimulating.....				
10 I feel aggressive and hostile towards computers.....				
11 I am sure I could do work with computers.....				
12 Figuring out computer problems does not appeal to me.....				
13 It wouldn't bother me at all to take computer courses.....				
14 I'm not the type to do well with computers.....				
15 When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer.....				
16 Computers make me feel uncomfortable.....				
17 I am sure I could learn a computer language.....				
18 I don't understand how some people can spend so much time working with computers and seem to enjoy it.....				
19 I would feel at ease in a computer class.....				
20 I think using a computer would be very hard for me.....				
21 Once I start to work with the computer, I would find it hard to stop.....				
22 I get a sinking feeling when I think of trying to use a computer.....				
23 I could get good grades in computer courses.....				
24 I will do as little work with computers as possible.....				
25 I would feel comfortable working with a computer.....				
26 I don't think I could handle a computer course.....				
27 If a problem is left unsolved in a computer class, I would continue to think about it afterwards.....				
28 Computers make me feel uneasy and confused.....				
29 I have a lot of self-confidence when it comes to working with computers.....				
30 I do not enjoy talking with others about computers.....				

**Part C**

1. How often do you use the WA Mathematics syllabus (please circle)? Once a

week	fortnight	month	term	year
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2. Do you find the WA Mathematics syllabus an easy document to use? - yes/no

If no, please explain why it is difficult:

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3. What do you use the syllabus for?

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4. Could the presentation be improved? yes/no

If yes, please explain:

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5. Did you find the old WA Mathematics syllabus better? - yes/no

**Part D**

1. Have you ever used a computer before? yes/no

If you answered no, please go to next page.

2. How would you rate your competence at using computers? (circle one)

very competent	quite competent	minimally competent	not at all competent
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3. What sort of computers do you use regularly? (please circle one or more)

Macintosh	BBC	Amiga	IBM-Compatible	Archimedes	other?
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4. Do you use a computer for personal work?    yes/no    If no would you like to?    yes/no

5. How often do you use a computer for school related activities? (circle one)

most days	several times a week	several times a month	several times a year	never
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6. How often do your students use a computer? (circle one)

most days	several times a week	several times a month	several times a year	never
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7. Have you attended a course on how to use a computer, since 1988?    yes/no

8. Do you use mouse?    yes/no

9. Can you touch type?    yes/no

10. Have you used:

(please circle)

- a) The cut and paste function (block move)?      yes/no
- b) A spell checker?      yes/no
- c) An electronic Thesaurus?      yes/no
- e) A hypermedia document/application?      yes/no
- f) A network using a modem?      yes/no
- g) A database to get information?      yes/no
- h) A spreadsheet?      yes/no
- i) A paint program?      yes/no
- j) A CD-ROM?      yes/no

**Part E**

**Hypermedia version of the syllabus**

Computers now have the potential to offer significant aid and assistance to teachers when they need to access the curriculum. For example consider the following situation concerning a prototype that is under development for the WA Mathematics syllabus.

The mathematics syllabus is stored on computer disk. You can move to any part of the syllabus by just clicking with the mouse on objects on the screen. By clicking on a word or entry code you can access relevant material eg. to a lesson ideas related to a word or entry code or glossary of mathematical definitions. The definitions, where appropriate, will contain graphics and speech. You can also access relevant material, such as remedial and enrichment materials, information on equipment and where it is kept at the school. You will be able to add to these documents eg. your own lesson ideas and if a word is not in the glossary, you will be able to add the word and definition yourself.

The whole syllabus plus the lesson ideas and glossary are on one disk. This is much more portable than the hard copy. It would be possible for the whole primary curriculum for all subject areas, plus all related documents and indication of access to other materials, to be stored on one CD-ROM disk.

a) If you had access at school to this type of software would you use it? (please circle)

never	some times	often	always
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b) If you had access at home also to this type of software would you use it? (please circle)

never	some times	often	always
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c) Do you think any of the following would be useful if present on the computer screen and directly linked to the syllabus objectives by only clicking the mouse? please tick

Access to	very useful	useful	not useful
a glossary			
lesson plans / ideas / concepts			
materials / equipment			
aboriginal / cultural information			
appropriate software for syllabus objectives			
remedial and enrichment material for syllabus objectives			
evaluation ideas and material related to syllabus objectives			

d) Could you suggest any other documents that would be useful to link and have access to while looking at the mathematics syllabus?

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## **Appendix 4 Teachers' comments on 'can presentation be improved'**

### **Part C4 - Can Presentation be improved? if yes - comment**

- Need for more overviews, ie easy reference system.
- An index or contents at the beginning of each section eg time PS 4, 5, 6.
- More dividers to label sections for each Year level. The three year levels make it more difficult to find the section or page you need.
- It's very bulky item and awkward to "take home" or carry from place to place.
- Prefer the lay out of the old syllabus especially for programming.
- Restructure within 3 strands to show progressive development of concept. Year level is secondary sort level.
- It could be set out so it's not so difficult to find areas.
- Make it easier to use.
- Not so complex and easier to locate information and related areas.
- Index to locate specific areas.
- Pages go astray.
- Too detailed. Needs to be more explicit. I prefer using WA pubs where activities / lessons are based on syllabus. Far less time consuming.
- Go back to the old format, at a quick glance you can see everything.
- Like the previous syllabus 85-90 percent with easy to follow ideas / activities to syllabus points.
- The syllabus could be set out with all activities following in logical sequence giving suggestions for revision and follow-up activities rather than in strands or perhaps both. Colour for strands but placed in order of sequence so that all of the syllabus is covered.

## **Appendix 5 Teachers' comments on how easy syllabus is to use**

### **Part C 2 - Do you find the syllabus easy to use - if no - comments**

- Plenty of valuable information, but difficult to access - not teacher friendly.
- Yes, however it is annoying in that there is no list of concepts covered or where you go to find them (page no), so you have to flick through the whole thing to find what you want.
- Yes, but it's far too bulky (still). I hate having to cart it home if I need to check on a certain concept. So try to avoid this and it therefor collects dust in my cupboard in between terms.
- It is rather unwieldy to use. You have to keep referring back to different sections. It is not laid out in sequences like old syllabus.
- Too bulky - requires 2 files. confusing - too much information!
- Document is too heavy and lengthy.
- Chapters don't progress by years therefor need to flip back and forth between grades to determine their level within specific topics as there is no easily determined / referenced sequencing.
- It's a pain in the neck because it's all over the place and not very easy to find particular components.
- Difficult to find relevant information quickly. Very bulky.
- When planning lessons you must search through document to choose appropriate associated activities and extension ideas. Returning them is a nuisance. It is overwhelming with its information.
- It takes too long to located particular activities, objectives.
- Very bulky. Time consuming.
- Takes time to find everything and always seem to be going from section to section and page to page.

## Appendix 6 Teachers' comments on links with other materials

### Part E - d - comments

Grouped by:

#### Video

- Video of great maths lesson(s); In class support to illustrate in practical terms the way in which to excel at teaching concepts.

#### Curriculum links

- I think it's an excellent idea and should be considered for all the syllabi and then perhaps some form of correlation function could be included where by similar skills in different subject areas could be linked eg classification - Maths and English.
- 7 x All other syllabus documents and integration of subject would be easy.
- Cross curriculum / integration and mixed grades.
- Appropriate connections to other syllabus areas eg Science practical situations from which to introduce / teach / use mathematical concepts.
- Other subject area activities that could relate to particular skills (eg Social Studies - mapping/grid references, Art - space activities, Science - problem solving activities.
- 2 x Science - especially measuring skills.
- 2 x The Language syllabus linked to some sort of thematic or whole language basis.
- Related links to Science, Language and other curriculum syllabus.
- Related syllabus entries / topics in Social Studies eg those where 'tables' are used and 'mapping skills' etc.
- 2 x Reference to content syllabi - Social Studies / Science skills which coincide with entries in the Maths syllabus links.

**Maths links**

- 4 x To link it with First Steps maths.
- 3x Evaluation class list structures / \* reporting system\* Teaching mark book, including some device to relate directly to assessment for reporting.
- 5x Student outcome statements / student profiles \* linked to school reporting system.
- Base line testing.
- Cross-referencing / sequencing of activities between strands.
- Have a computerised checklist so you can highlight what you have done or are interested to do each term and print out facilities so it can be used to write maths programs.
- Integration of ideas through space, measurement and number.
- Link up with commercial materials.
- Literature related support books.
- Making activity sheets related to syllabus objective's student outcomes for evaluation of classes.
- National Profiles / link with First steps strategies / district office equipment / resources available / Maths link language.
- Sample worksheets already prepared, sample test sheets, Activity cards - Ministry Pub.
- Student database to cross reference.
- Student outcome statements First steps learning and developmental continua.
- Young Australian Integrated Maths program.
- Sets of 'real life' problem solving word problems rather than number problems.