TO DESIGN AND TEST THE EFFECTIVENESS OF COMPUTER BASED LEARNING IN SUPPORTING TEACHING AND PROMOTING STUDENT LEARNING IN MICROANATOMY

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A thesis submitted in partial fulfillment of the requirements for the degree of Magister Philosophiae in the Faculty of Education, University of the Western Cape.

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KEYWORDS

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Education

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Learning theory

Information technology

Self-testing computer program

Computer-based learning

Multimedia

ABSTRACT

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M.Phil thesis, Faculty of Education, University of the Western Cape.

The 1990's have brought some critical challenges to medical and dental students. The amount of information necessary to function effectively in the medical profession is expanding. This knowledge explosion results in curriculum crowding, making it more difficult for students to master the curriculum. The problems encountered when studying the course are retention, understanding and application of basic science information.

The dentistry students at the University of the Western Cape encountered several problems studying the histology course, viz. the short time allocated to assimilate an immense amount of knowledge, integrating theory (the lectures) with the practicals (microscopy) and the orientation and identification of sections on microscopic slides.

A series of revision programs were designed in histology using a Macromedia Authorware program. Each program has a set of light micrographs with relevant text. Images are labeled to orientate and help students to identify the sections. These programs are incorporated into the curriculum to assist students in the mastery of important concepts in microanatomy. A test was added to the program, which allowed students to assess if they had mastered the chapter(s) they were revising. Students were given time to use these programs, alone or in groups, for as long as they needed and as often as they wanted to use them.

They were also given questionnaires in which they were asked to evaluate the programs as well as the testware.

The results showed that they enjoyed using this innovative means of studying. They felt the computer based instructional programs definitely enhanced the course. Multimedia tutorials also created an environment that encouraged peer learning and peer teaching. Being able to assess their knowledge once they had completed the chapter was not as traumatic as a class test.

In its initial stages, these programs have shown to be an effective tool for the learning and self-testing of histology. It is clear from the results that students found this an interesting way to learn histology.

DECLARATION

I declare that *To design and test the effectiveness of computer based learning in supporting teaching and promoting student learning in microanatomy* is my own work that has not been submitted before for any degree or examination in any other university, and that all the sources that I have used or quoted have been indicated and acknowledged as complete references.

Pamela Edna Delport

Signed: P Delport

Date: 28 November 2002

DEDICATED

To the memory of my father, Arthur Timm

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INTRODUCTION

Motivation

"On the surface it would appear that a major revolution is occurring in medical education. The proliferation of computer applications to support medical education and the significant investment of medical schools in computing hardware for education combine to suggest that computer technology is having a significant impact on medical curriculum." (Friedman et al, 1992).

With this major resolution comes new concepts, terminology and continuously changing fields of instruction. Seels (1994) in an article on creating formulae for Instructional Technology gives a definition by the Association for the Educational Communications and Technology which states: "Instructional Technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning." (Oosthuizen, 1995).

The present research explores and evaluates the use of instructional technology in support of the learning and teaching of the histology course of second year dentistry students of the University of the Western Cape.

Some of the domains of the field are covered in this research, for example, design and development, utilization and evaluation.

Computer based programs of the microanatomical course of the dentistry curriculum were designed, developed and installed onto computers in the anatomy department. Students were allowed access to the programs during tutorials and practicals, and also at any other time they felt they needed to revise the course. They were also afforded an opportunity to evaluate the programs by means of a questionnaire and the programs were upgraded on a regular basis.

Research Questions

1. How effective is computer based instruction, developed in-house, in supporting teaching and promoting student learning in microanatomy?
2. What are the problems of the current histology course offered and can computer based learning offer solutions to these problems?
3. How are the effectiveness of the programs prepared for the students evaluated?

The Anatomy Department of the University of the Western Cape teaches an anatomy course to second year dentistry students. This course is divided into four modules viz. gross anatomy, neuroanatomy, microanatomy and embryology.
The anatomy course is characterized by a lecture-centered approach, ie the lecturer controls the course, content and the way the lecture is presented. The emphasis is on teaching the subject, rather than the student learning the subject.
The Anatomy Department also has a computer laboratory of 20 computers. These computers are not utilized to their full potential, this being to the detriment of the department, lecturers, students and curricula, as well as research. The department should use this facility and technology for the improvement of curricula and students.

This research will introduce and promote information technology in the histology course of the existing dental curriculum with the existing academic and technical support structures.
This thesis describes the development of computerized programs to promote an innovative way of studying this module.
A series of revision programs have been designed, on the basic systems of the body, to assist dental students in the mastery of important concepts in microanatomy and in addressing several problems students encounter in the histology course.

The aim of this thesis is to develop and evaluate the effectiveness of these programs designed for second year dentistry students taking the histology course at the University of the Western Cape. There is a tutorial program, as well as a self-testing program. The purpose of these programs is to provide students with a concise but fully illustrated account of the microanatomical structures of the systems of the body and to aid the instruction of histology, a required course for second year dental students at the University of the Western Cape.

Background information

Students often feel that histology is a boring subject. Most times it is because of the passive way they have learnt the subject. The idea behind developing hypermedia courseware and testware is to gain the interest of students by moving them from passive recipients of information to active participants in knowledge construction, that is to get them to interact with the module while they

are revising (Whittaker, 1989). This would also reinforce the idea of Sims of developing a greater recognition of the importance of allowing students time to discover and learn on their own using non-didactic methods (Sims, et al, 1990)

For students there is also a short time to assimilate an immense amount of knowledge. The lecturer has to go at a pace that will allow him/her to complete the syllabus. The time used for learning a particular module differs from one student to the next. These programs are designed to give students the opportunity to revise the module as often as they please, taking as long as they need.

The contents of the microscopic slides, used in histology, are not labeled and therefore students have to depend on lecturers, teaching assistants or atlases to assist with identification (Alper, 1992). Also there is only one lecturer with two teaching assistants, in the practical sessions, for a class of forty-two dentistry students. Therefore students are forced to wait for long periods until someone can address their problem (Alper, 1992). These programs are so designed to allow students to revise with less assistance, and if possible with no assistance at all.

Another problem in histology is that students cannot integrate theory (the lectures) with the practicals (sections viewed in a microscope). These programs are designed to combine a text and glossary with relevant fully labeled micrographs on the same electronic page, trying to assist students with this problem.

These programs are designed to enhance the course and not to replace it, therefore students are expected to use them as an added 'educational tool' to their course (Whittaker, 1989). It will be incorporated into the curriculum so that students do not have to use excessive time in mastering the subject.

Workstations with the programs installed, should be found in a media room close to where the students do their practicals as suggested by Friedman and his colleagues (1992). They will provide students with immediate access to the programs and the computer environment will become part of the student's general learning environment.

Another objective of these programs is to encourage individualized instruction. The design of these programs are based on mastery learning followed by a diagnostic test of the students' knowledge. For slower learners these programs could be used as an opportunity to learn at their

own pace and assess their own performance. The students could therefore discipline themselves to master one chapter at a time and at their own pace (Spencer, 1990).

Although lectures, microscopic slides, books and student interaction in tutorials are still the mainstay of teaching histology, incorporating independent learning modules in the form of these computer programs can be an effective 'educational tool' to support the instruction of histology. These programs are designed to aid and not replace the instruction of histology (Whittaker, 1989).

Through this study we hope to produce computer based programs to provide an innovative means for students:

- To study a subject often said to be boring.
- To create an environment that will encourage peer learning and teaching.
- To afford students the opportunity of assessing their knowledge before entering a class for final examinations.

This thesis hopes to create awareness that, despite the present retarded pace in the effective utilization of computers in the anatomy department, a real revolution can happen if computers are used to their full potential.

Learning histology as part of the anatomy course for second year dentistry students, in the Anatomy department of the University of the Western Cape will become both enjoyable and effective and also many problems encountered in the course will be overcome.

CHAPTER 2

LITERATURE REVIEW

Motivating innovative learning skills in medical and dental education

"Medical students believe that medicine is the best of all professions and worthy of the time and energy it cost" (McFarland and Rhoades, 1996).

Medical students, including dentists, nurses, etc, begin these degrees in medicine recognizing that they will need to learn a large volume of material. Yet they are often surprised by the amount of material presented and the time needed to learn even a fraction of it. Some become discouraged and question their own capabilities.

There is now an information explosion that has to be mastered by medical and dental graduates. The information needed to be learnt to gain a general understanding of the course is expanding continuously as medical researchers are more successful with image analyzers, scanning and transmission microscopes and other cytology techniques such as immuno-cytochemistry and cell cultures. There is now an information explosion not only in this course but also in all the others that have to be studied by medical undergraduates. Most students have trouble retaining all this information.

There is so much research done in this field, adding more and more facts to the subjects taken by these undergraduates and expanding the curricula to such a degree that it becomes impossible for students to manage these courses (Cohen & Forde, 1992; Parsell & Bligh, 1995).

Also the way this curriculum is taught traditionally as independent courses has attributed to curricula overload. There is lots of repetition between courses. Most students have a problem with retaining all this information and integrating the one course with the other to have an overall understanding of the field in which they are studying and going to practice.

Medical and dental schools should identify the core curriculum and reduce the content of undergraduates medical education to relevant information needed to understand the course. To help students overcome this problem a process should be established whereby the curricula needs to be evaluated so that it can "sift out" all the irrelevant and outdated information and focus on critical, relevant information for the chosen course.

Parsell & Bligh (1995) claim that the need to redefine basic medical education has been fully recognized and accepted by medical schools around the world and educational principles on which curricula should be based have been put forward to various universities. However today one finds that the amount of information needed to be learnt to gain a general understanding of any medical course is still expanding continuously. To survive the rigors of these courses students adapt by learning what is necessary to pass and do well academically. The assessments of the lecturers are tests, which measure how well students acquire scientific knowledge.

According to Fairclough and Carotte (1995) a research of literature revealed several papers addressing factors that influence student learning. Some of them are:

- Hendricson and colleques carried out a four year study of the dental student learning styles and found that students preferred factual and concrete information, a structured curriculum and an organized learning environment.
- Laurillard found that students' styles and strategies of learning are context-dependent and that descriptions of learning will be found to apply to groups of students in particular learning situations rather than individuals.
- Chambers found a strong correlation between the workload and the quality of learning: the more that is expected of students, the more likely they are to adapt a surface approach.
- Entwistle and Entwistle carried out an extensive survey and found that many students adopt a 'reproducing' rather than 'transforming' approach to learning for examinations.

Surface learning techniques, also known as rote learning, have long been recognised as an ineffective way of learning that requires the memory but not the mind. Knowledge gained this way does not encourage critical thinking processes and is easily forgotten. Students memorise facts and become passive learners just to pass the examination at the end of the year. Traditional methods provide limited opportunities for students to develop areas of knowledge, interest and skills that encourage motivation and independent learning.

Medical students have been challenged to diminish the rote and passive aspects of their educational programs, particularly in basic sciences (Friedman, et al, 1990).

Traditional teaching methods of a lecturer as sole information-giver to passive students appear outdated.

> "In a study by Berkeley on undergraduates in a large lecture hall setting, it was found that only 20% of the students retained what the instructor discussed after the lecture." (Hanley, 1994) .

They were too busy taking notes to internalize the information. The emphasis is on learning the answers more than exploring appropriate questions, memorizing bits and pieces of information instead of understanding it in the context it is given, recitation over argument, reading in lieu of doing.

The aim is for students to absorb as much terminology and text as possible taught by lecturers, to enable them to pass the final exam.

Print media vs electronic media

"Print media, as a way of learning, has a long, valuable history that sometimes this make it difficult to be replaced by electronic technology" (Jaffe & Lynch, 1996). Print media comes in various forms like books, journals, and bulletins and can be easily distributed through bookshops and mail orders. Libraries increase their availability and accessibility. However books are becoming very costly, quite an effort to create, and quite an expense to print.

- The time it takes from putting the idea down on paper to its appearance on the shelf, are months, sometimes even years.
- Most times a book remains on the shelf long after the information has been outdated and changed and at the current rate of medical discovery, this may be to the disadvantage of medical students.
- To save on cost most of the text and images are a dull grey colour because printed colour images are expensive.
- Books are often very dependent on text for describing visual articles. Although text can help in understanding, it is better to actually see the image and even better to interact with the section while learning.

For many years lecturers and students of tertiary institutions have been working within a scholarly paradigm dictated by print technology. Books and articles have been produced allowing for "fixed" text, which falsely leads one to believe that the knowledge within these books is true, fixed and stable. This school of thought has not motivated scholars to be objective about the knowledge, be authoratative about what they learn and find procedures of acquiring more knowledge on the topic. Many literacy, cultural and scientific theorists have been questioning and criticising this "traditional" academic school of thought during this past century.

Undergraduate students are not trained to integrate the knowledge they gain in various disciplines of their courses e.g. anatomy with histology and embryology or anatomy with physiology or pathology. They see them as separate courses and study them separately.
Understanding the subject, implementing the knowledge in practicals and tutorials, or even integrating the knowledge acquired with other courses such as physiology or pathology is something students seem unable to achieve.

Face to face collaborative learning, with lecturers, is still encouraged; however collaborative learning is also recognised as an effective transitional factor to be implemented in supporting development of higher education scholars. Therefore even though the traditional learning procedures have their advantages, overcrowded curricula call for more innovative ways of being able to master university courses.

The motivation, enthusiasm and curiosity that students have at the beginning of the course soon disappear under the banner of a compact curriculum. The enthusiasm can be maintained with innovative methods of study.

Medical educators need to find more innovative ways of overcoming this problem. Some of the solutions could be:

- By finding more creative ways of teaching the lessons
- By focusing more on student learning methods than lecturers' teaching skills
- By finding more "creative tools" to teach the subject.

When courses are developed one should make sure that they are student centered, ie learners are the key focus. Learning in a tertiary institution should be based on principles of "adult" learning which is suggested in an article by Parsell & Bligh (1995):

- Learners should build on previous learning experience (therefore should be taught not to rote learn)
- They should be able to identify their own needs knowing which discipline they are going to specialise in
- They should be involved in planning their learning (ie. possibly be able to select from 10 assignments which one they want to research)
- There should be a process in place where students can evaluate their learning (possibly a self-testing system).

Students should be encouraged to take greater responsibility for learning decisions and to question what and how they learn. That would mean the traditional role of lecturers would change in many ways. The aim should be to use methods of education rather than instruction. Students must be taught: how to collect facts, how to verify them and how to sort out all the information and come to a conclusion.

The lecturer's focus should be on the method of learning and understanding the subject rather than the knowledge of the facts. Facts can easily be forgotten but the method to acquire knowledge in that field will remain with them for the rest of their lives, for example using mind-maps, computer-based programs or websites, etc.

As early as 1988, the World Federation of Medical Education issued the Edinburgh Declaration of 12 principles for reforming medical education. (Bigum, 1998).

Those relevant to the dentist are:

- Widening education settings in which education now has to take place
- Active learning throughout life (with appropriate reform in the examination system)
- Professional competence as a purpose for all learning
- Training of medical teachers as educators
- Integration of science and clinical practice

- Selection of entrants for non-cognitive as well as intellectual attributes.

These are principles that should be considered when evaluating or developing curricula in the new millennium changing the style of undergraduate students. Course focus should be to reduce the overload to a certain extent, when working with the curricula. The aims and objectives should be based on substantively reducing factual information. A curriculum should be based on essential knowledge and skills. It should promote and encourage learning through curiosity and exploration. The process should encourage integration of courses. It should also include modern educational theory and technological resources. Finally to make sure that the procedure followed is the correct one, the course should include an assessment method that will encourage students to learn by critically acquiring and understanding what they are learning or have learnt.

There is no opportunity or encouragement given to students to work together, to share ideas and information, or to use modern instruments and equipment to extend their intellectual capabilities. Many scientific theorists have, therefore been motivating for and initiating new communications technologies as an alternative to print. They have also been challenged to introduce computer technology as a topic of study as well as a tool to promote mastery of the various disciplines.

There is also a realisation that traditional forms of the course delivery do not prepare students adequately for success in their studies and more so do not prepare students for the dynamic workforce of the secular world. Therefore universities are moving towards delivering part of their courses through lectures and part by using computers which allow students to learn at their own pace and in their own time

To help the process change from traditional to innovative courses can become a problem. This is where technology can assist. We need to learn to make effective use of computers to overcome this problem. If most problems seem to be retention of information and the ability to train more broadly competent dentists in future, then we need to help students overcome this problem with the help of technology.

Multimedia Programs

The computer is an educational tool and as a tool, the computer should be used by lecturers and students to aid learning and assist in academic work, i.e. teaching and learning, not forgetting administrative work too.

"Some people think about computer literacy as a new and very important technique like reading and writing." (Su & Kohl, 1995).

To make sure that all students are "computer literate", computer literacy courses are offered at schools, and for those who come from disadvantaged backgrounds, and were not afforded the opportunity of using computers at schools, a computer literacy course is offered as a first year subject at most tertiary institutions in South Africa. Therefore once students enter the second year, they know how to use a computer.

An environment with computer-facilitated instruction will help to broaden learning opportunities for students, especially medical and dental students whose courses are becoming more and more overcrowded. Computer-based learning will extend and enhance lecture experiences.

Many researchers claim, " the introduction of computers in medical education has been accompanied by changes in structure of the educational program. Proposals for innovation in medical education have often emphasised the potential role of computers." (Friedman et al, 1992; Najjar, 1996).

Information technology has the potential to revolutionise the way medicine is learnt by students. The medical and dental students need to be familiar with the application, use and scope of information technology, computer-assisted instruction and computer-based learning. Computers need to be used to aid learning in the medical field. If these methods are used effectively they will encourage self-directed learning and better integration of knowledge.

Multimedia tutorials can also create an environment that will encourage peer learning and peer teaching and can help to bring different experiences to student learning.

Developing multimedia courseware is not always expensive; it can be developed more cheaply in an educational context than in a commercial environment (Harriet, et al, 1997). Lecturers with

relatively little training can develop low technology interventions. Content experts delivering new material to the department or multimedia specialists developing to departmental specifications can also deliver the courseware. Therefore one could say that including multimedia technology in teaching could also be a means of increasing the effectiveness of teaching processes.

Software should be developed in such a way that will assist students to move away from the ever growing burden of memorising facts and introduce them to the application of computer technology which will assist them to be more creative in their learning methods.

The diversity in learning procedures such as their achievement level approaches to learning and cultural backgrounds will also help to address the wide range of backgrounds of students doing courses at the University of the Western Cape.
Multimedia courseware if designed, developed and managed properly could also help to bridge the gap between poorer and better prepared students allowing for flexibility and offering the capacity for personal feedback, which not all lecturers can manage in large classes. Students and staff can also get test results and feedback immediately.
The approach of using computer based programs is not designed to stand alone but rather to be integrated with other learning resources, such as lectures, face to face experiences and printed text.

Implementing multimedia programs into the educational content requires careful planning of the following:

- Courseware design – when designing the programs there are different components to consider, ie the content, the structure and the style realising that the learner's brain has limitations and can be easily overloaded with information. Also allowing for innovative ways of working with and through the program. (Bijker, 2001)
- Integration into curriculum – the program should be integrated into the course in such a way that students can see the relevance to the course. It should blend in with departmental practicals and assist with student assessments. It should not be seen as an optional extra, unrelated to the course itself. Therefore it has to be accepted and owned

by the department and integrated into the course right from the beginning with the initial planning, design and development stages. (Whittaker, 1989)

- Accessibility – computer laboratories containing the programs should be easily accessible to students at any time during the day, allowing students to work alone or in groups depending on what suits them (Friedman, et al, 1992).

The learning environment should consist of:

1. A friendly and informal physical work place that is appropriate for single students or group interaction (2 to 3 students per group).
2. There should be computer-assisted programs dealing with the relevant chapters of the course.
3. A tutor to guide and assist where necessary, but not to teach.

Multimedia courseware and other computer based learning tools can offer many of these advantages to enhance conventional teaching methods, but only with careful attention to planning, development and delivery of computer based material.

"Information technology has the potential to revolutionise the way medicine is learned by students and healthcare professionals" (Mooney and Bligh, 1997) McFarland and Rhoades (1996) claim that this is where technology may assist. Learning to make effective use of computers could help to assist with some of the problems created by trying to master the courses.

Electronic text is rapidly developing in tertiary institutions as a way of teaching and learning. (Bennett, 1997: Friedman et al, 1992; Mooney et al 1999).

Scholars have been predicting a revolution in the academic publishing world since the early 1990's, including university centered distribution, extensive on line peer review and innovative multimedia enhancement (Burg Wong, et al; 2000).

The use of computer based learning in medical education is gathering momentum that is fed by significant advances in both information technology and medical education. The procedures through which academic courses are conducted are moving from printed text and face to face

lectures, to the new electronic forms of hypertext, hypermedia, computer-assisted instructional programs and the internet.

Friedman and his colleagues also claimed " the introduction of computers in the medical education has been accompanied by changes in the structure of the education programs. Proposals for innovation in medical education have often emphasised the potential role of computers". Information technology in medical education, including dentistry brings new challenges for educators. The focus of instruction is shifting from didactics towards emphasising and encouraging independent active learning. Friedman and his colleagues affirmed this in an article, when they claimed, "on the surface it would appear that a major revolution is occurring in medical education. The proliferation of computer applications to support medical education and the significant investment of medical schools in computing hardware for education, combine to suggest that computer technology is having a significant impact on medical curriculum." (Friedman, et al; 1992).

Throughout the world medical faculties of other universities have made great advances in the medical field, as a result of better utilisation of the computer. (Whittaker, 1989; Alper, 1992; Furman, 1992).

Many scientists have realised this, especially those in the medical field. Lecturers have now realised the importance and effectiveness of information technology. The growing number of relatively inexpensive personal computers also brings with them many opportunities for the use of computers in medical education.

Bennet seems to support this when he claims "today's technology, if used differently could bring advances that would improve education dramatically. Ordinary students would make massive gains, and restraints on bright students would dissolve...." (Bennet, 1997).

CHAPTER 3

EDUCATIONAL COMPUTING

It has been over thirty years since educators and computer scientists began using computers for instructional purposes. In that time span incredible advances have been made in computer technology and its ability (Alessi & Trollip, 1991)

- During the 1960's and most of the 1970's instructional computing took place on large mainframe computers. During this time educational computing existed only at large universities and was restricted to reading and typing text, and drill and practice courseware.
- By at the end of the 1970's when the microcomputer was developed there was a rapid spread of computing in businesses, universities and schools. These computers also had more facilities and allowed for interaction through text, graphics, voice and pointing.

These computers have now been developed with large megabite capacity and have become easier to use through the addition of advanced visual and auditory devices.

DEVELOPMENT OF COMPUTER MEDIATED INSTRUCTION

Computer mediated instruction is an educational medium in which instructional content or activities are delivered by computer. Students learn by interacting with the computer and appropriate feedback is provided. Several acronyms represent the use of computers in educating students. These are:

CAI: Computer Assisted Instruction

CAL: Computer Assisted Learning

CAI: Computer Aided Learning

CBI: Computer Based Instruction

CBL: Computer Based Learning

Throughout the rest of this thesis, computer based learning will be used.

One must realise that the early days of using computers for instructional purposes were very exciting for its potential and many scientists proclaimed great educational improvements using computer-based learning.

Computer based learning has become more feasible as a result of the growing power of the desktop computer. The development of desktop machines with greater speed, high resolution colour and larger memory helped to improve computer technology. Hardware advances led to extensive mass storage as well as individual CD-Rom storing devices (Furman, 1992).

But while there have been great strides in the improvement of computer technology and its availability, the actual improvement of instruction has not developed at the same speed for several reasons, viz.:

- Initial instructional computing became very confusing because of the many types of computers on the market. This also created problems in hardware and software compatibility.
- Lots of money is spent on purchasing hardware, but not much is set aside to purchase or develop new software.
- The selection of courseware is another problem. Most times when books are purchased they are carefully selected but the selection, evaluation and purchasing of software is not often very satisfactory and not only results in a waste of money but also creates despondency in students against using the software to enhance their learning. (Chapter 5 of this thesis confirms this).
- There is a shortage of skilled courseware developers (resulting in a low quality courseware).
- There is much disagreement amongst educators and developers about how computers should be used in education.

All these factors have hindered the effective use of computers in education

WHY MULTIMEDIA FOR INFORMATION AND LEARNING

Multimedia is the use of text, graphics, animation, pictures, video and sound to present information. Since these media can now be integrated using a computer there has been an increase in computer based multimedia instructional applications. These applications run from

educational entertainment products for children to computer-based tutorials for adults. However they all have one aim, to help people learn by using multimedia.

According to Najjar (1996) much research has been done to show that people:

- enjoy multimedia
- prefer multimedia learning material
- believe that multimedia helps them learn

"One widely cited and completely supported assertion is that by Treichlar 1967. People generally remember 10% of what they read, 20% of what they have heard, 30% of what they see and 50% of what they hear and see" (Najjar, 1996). So people generally believe that multimedia helps them learn. Multimedia information is also most effective when:

1. It encourages the dual coding of information

According to the dual coding theory (Pavio, 1986; Clark and Pavio, 1991) information is processed through one of two generally independent channels. One channel processes verbal information such as text and audio. The other channel processes non-verbal images such as illustrations and sounds in the environment. Information can be processed through both channels. This occurs, for example, according to Pavio, (1991) when a person sees a picture of a dog and also processes the word 'dog'. Information processing through both channels is called referential processing and has an additive effect on recall. Learning is better when information is processed through two channels than when information is processed through only one channel. It may be because the learner creates more cognitive paths that can be followed to retrieve the information.

2. When media support one another

Multimedia information seems to improve learning when the media show closely related supportive information. For example, Peeck (1974) asked fourth grade children to read a story with supportive illustrations or without illustrations, and measured the learning via multiple choice questions and verbal recognition tests. It was found that retention improved when the text was accompanied by supportive illustrations.

3. **The media are presented to learners with low prior knowledge or aptitude in the domain being learned**

Mayer (1993) believes that this is because the multimedia helps low domain knowledge learners to connect the new knowledge to prior knowledge. Multimedia may also make more important information more obvious. However, learners with high domain knowledge have a rich source of prior knowledge that can be connected to the new knowledge. In a study by Mayer and Gallini (1990) college students read text with and without illustrations that explained the operation of the drum brakes of cars. For college students with low prior knowledge of the drum brake operation, the illustrations improved their recall of explained information and their ability to solve problems related to the explanations. For college students with high prior knowledge, the explanative illustrations did not affect their performance.

This example suggests that multimedia is most effective for people with low prior knowledge or aptitude in the domain being learned. Those with high prior knowledge already have a cognitive model and large amount of information for new knowledge to connect to. Also those with low prior knowledge may not know which information is important and on which information they should focus their attention. Multimedia programs can assist them.

Multimedia may also improve learning by allowing knowledge experts, instructional designers and programmers to use the most effective medium to present specific information.

The following procedures suggested that Najjar (1996) for design and development tends to work well.

1. Assembly instructions – it was found that students with text and pictures made fewer errors than students who used text alone.
2. Procedural information – diagrams and explanatory text help students acquire an understanding of the subject they are studying.
3. Recognition information – to communicate information that students need to recognize, pictures are extremely effective. However, recognition accuracy for pictures and text are better than pictures alone. Pictures seem to allow very rich cognitive encoding that allows high recognition rates.

4. Spatial information – illustrations are superior to text when learning spatial information. Researchers Bell and Johnson (1992) allowed people to select pictures or text for communicating instructions for loading a battery into a camera. Results show that the people preferred pictures and illustrations to text. Researchers believed that the information to be used was spatial and results supported the hypothesis that spatial information should be presented using pictures.

There is more than enough support for using multimedia to help people learn specific kinds of information. These advantages seem to be due to the ability of certain multimedia combinations to support the way people understand, organize and access information (Najjar, 1996).

NEGATIVE ATTITUDES

Many academics use several reasons why they should not use electronic technology as a form of enhancing learning in courses and these are stated in an article by Jaffe & Lynch (1996). They claim that a computer has some embarrassing deficiencies.

Some of them are:

- It is big and bulky and therefore is inconvenient to carry around. (The invention of laptops seems to have overcome this problem.)
- It needs electricity. (All lecture rooms, laboratories and study facilities have power points. Plugging one in at home should also not be a problem.)
- There is no standard hardware. (Universities usually purchase in bulk and therefore have the same kind of machine in their computer laboratories.)

There is also the problem of computer literacy but secondary and tertiary institutions offering a basic computer course as one of their subjects are overcoming it.

Computers have become essential in the medical field for creating medical images. They allow for image organising, collection and storage. The computer screen is colourful, allows for brightness and a creative display tends to enhance imaging and therefore also enhances learning.

Stand-alone desktop machines have sufficient speed, resolution and storage to allow for the developing of very effective courseware to meet the needs of medical courses. Jaffe and Lynch claim that a CD ROM with about 650MB digital capacity, has the ability to store quite a large program, with over half an hour of video and is not very costly (Jaffe & Lynch, 1996).

Advances in computer based learning depend on the creation of more software that can take full advantage of 'state of the art' technology. However there is also a need to develop software that utilizes the vast resources already available at most institutions and for personal computers that individuals already own.

Tools for software construction have ever increasingly easier ways of generating computer code and authoring development software like Micromedia's Authorware that can enable educators to construct and print their own software on desktop CD Rom writers.

Students learn at different rates. Lecturers must consider the learning needs of the student and use technology in the course to facilitate this goal.

There are several reasons why we should use technology to enhance to medical curricula. Technology can foster an increase in the quantity and quality of students' thinking. It creates an innovative and interesting way to learn. Students need high level and interesting courses.

The focus of medical learning is shifting to rely less heavily on didactics and more on emphasizing independent active learning. Although books, models, posters, slides and faculty interaction are still the mainstay of teaching medical courses, incorporating independent learning modules on computer with images, text and glossaries is also effective. Studies that compare didactic learning with independent learning report that students enjoy these alternative methods (Friedman, et al, 1990; Furman, 1992; Najjar, 1996).

Although lecturers cannot depend solely on technology for teaching a course to learners, they can also provide technology for thought provoking and stimulating avenues of study. Technology can help institutions and lecturers to become more productive and efficient in instruction.

It has been realised that there is a need for all health professionals to acquire technological knowledge in order to practice their profession. Everything is computerised today; even administration work is done using certain programs. The use of computers as an educational

resource, included in the curriculum for all the undergraduate years, should help students gain confidence and competence before venturing out into the clinical world.

Computer based learning can enhance medical education, but course directors and curriculum designers need thorough, credible evaluative data to make sound decisions about proving the effectiveness of and implementing computer based programs (Glenn, 1996). Also curriculum designers and program developers should carefully consider whether or not computer based learning really needs to be part of the curriculum, as well as the quality of the program, before implementation takes place.

Curriculum and program designers need to assess the following before making a decision about implementing or making the computer assisted program as part of the curriculum. They are:

- Facts about the strengths and weaknesses of the program as compared to traditional modes of instruction.
- Evaluative information about scopes and merits of the program.

Comparisons should also be made as a form of assessment. The innovative program should be compared with:

- Another computer-based program or approach
- Improvement in performance in examinations attributed to the use of the program
- Whether the computer-based program decreases the time students need to master a certain body of knowledge.

CHAPTER 4

EVALUATION OF COMMERCIAL PROGRAMS

There is the realisation that technology can be used very effectively in the medical field, especially in the anatomy department of the University of the Western Cape.

Several computers have been purchased for the Anatomy department. The computer laboratory has been set up and several commercial programs in anatomy and histology were purchased. These included three programs in histology developed on CD-ROM. These programs were purchased because the students were using the textbooks of the authors who developed the CD-ROM and the price was reasonable.

Students were given the opportunity to use these programs during practicals and tutorials, especially for revision when it came close to examination times. After a while it was realised that they did not use this facility very often. They would rather spend time in the computer room, using textbooks for revision.

It was decided to evaluate these three programs to find out why students were not using this "extra tool" to enhance their studies. With twenty years of experience in this field, I decided to evaluate these programs, comparing them with the requirements of curriculum including practicals and tutorials and to find out if they were 'student-friendly'. Students were also asked to explain why they were not using this facility.

I have tried to assess and compare these programs to see if there is one that could be used as a "testing" program for my thesis. The following facts were taken into consideration:

- The program has to be well laid out and easy to operate, so that the student would not spend too much of his/her time learning to use the program.
- The program has to have the relevant micrographs, which are suitably labelled, to help orientate students to use the micrograph, and also help them to identify certain structures in the sections.

- The text must be concise, being aware of the students' heavy workload and also their limited time on the computer. However, the text has to be informative enough to create an understanding of the image.
- A self-evaluation program needs to be included to help students assess themselves ensuring that they have mastered the module they are revising. If possible this data also needs to be accumulated so that the lecturer can assess it.

The following programs were evaluated.

- Wheater's Interactive Histology by Wheater, Burkitt, Young, Heath, Stevens & Lowe
- Microscopic Anatomy by T Hollinger
- Human Histology by Stevens and Lowe

WHEATER'S INTERACTIVE HISTOLOGY

DESCRIPTION

This is a multimedia CD-ROM textbook of histology. It has 850 pages of 1200 images and text. It is extensively illustrated with colour micrographs and illustrations giving extensive detail of the structural features of cells.

The subjects are:

- Functional Histology
- Basic Histopathology
- Self-Assessment in Histology

A fully interactive self-test module allows for continual performance feedback and a brief evaluation at the end of it.

THE STRENGTHS OF THE PROGRAM

- It has a toolbox, which is self-explanatory and therefore allows for easy navigation through the content.
- It has a filmstrip of all the images of a particular chapter, all the time on the screen and this aids the navigation through the chapter.
- It has a search dialogue box, and with the aid of keywords, it searches for text and images.

THE WEAKNESS OF THE PROGRAM

THE TEXT – It displays two sets of text.

- The one set, is the introduction to every chapter. This remains on the screen throughout the chapter. This introduction has no relevance to the micrographs that students are viewing on the chapter. It is general knowledge about the module. It is long and wordy and might even distract students from the relevant information.
- The other set of text has reference to the images that are being viewed on the screen. This text describes three or four micrographs at the same time. This causes it to have too much information in one box, at one time. Students still have to extract relevant information to one particular micrograph. This is time consuming. All this information put together at one time, seem to cause confusion and students will not know which micrograph to look at when seeking definite information on a particular cell or structure.

With all this information put together at the same time, the students will take a long time to cover one chapter. Students are looking for short concise text, but it should give them a "clear" understanding of the module they are revising. Each student will also be limited to the time they are allowed for each module because there are several modules to cover. Because there are two sets of text, the boxes for each text are very small, and students have to scroll over lengthy text to be able to read everything. This can become a strain, if it is done over a long period of time.

THE DIAGRAMS

The labeling of micrographs is very small, and very indistinct. To be able to obtain clarity, one has to magnify the area. This program allows for this facility, but if the diagram is magnified the text is lost which gives one a clearly labelled micrograph with no text to guide the student through it.

SELF-EVALUATION PROGRAM

In this part of the program, the images relating to the questions are not very clear and response to the questions is by means of true or false answers. This allows plenty room for guessing and therefore does not really give one a true idea of whether students have mastered the module or

not. However, the fact that students are given immediate feedback when responding incorrectly is definitely a strong point. The performance is also rated in average percentage on all questions covered by the student.

MICROSCOPIC ANATOMY

DESCRIPTION

This multimedia CD-ROM contains 1300 colour photographs of typical histological specimens, each supported by textual information.

The program organisation is as follows:

- A title screen, which has a list of chapters.
- A list of slides with accompanying text
- A list of slide images

From the title screen a chapter is selected. This brings up a list of all slides associated with the chapter (in no particular order). A list of slides is chosen, which is to be studied, from this catalogue. Once these have been selected, the student will click on a "Button" which allows one to access the slides that have been selected. The screen shows a category title for each slide, an image box, an image information box and a text box. On the image there are two different coloured arrows used as indicators and the structures indicated will be described in the text.

Added to this program is a self-evaluation section. A "Quiz" button allows one to enter the self-evaluation mode. This brings one to a self-evaluation options screen. Students can select topics they wish to be tested on and then click on the "start" button to begin the examination.

STRENGTH OF THE PROGRAM

- It has a chapter on the microscope in the form of a 5-minute video. In this chapter all the parts are discussed and it also illustrates how to operate the instrument. It has sound to the video, which makes it user friendly. Students that are slow readers or do not like reading can just enjoy listening to the instructions.
- It has an index of all the slides in the program, naming the species and how the slide was prepared. However this is good information for the lecturer but has very little relevance to the students.

- Indication by colour arrows on the image, and relating this to the text helps to orientate the students to a certain extent, while reading the text.
- There is an image information box about the section on the screen, and how it is prepared. This is also good for the lecturer but irrelevant to the student.
- The self-evaluation part of the program. The questions come in the form of multiple-choice questions, which do not allow for guessing and students are given immediate feedback to their wrong answers.

WEAKNESS OF THE PROGRAM

- There is no definite system in viewing the slides for a particular chapter. Once students have indicated the chapter they wish to study, they are presented with an index of all the relevant slides. They extract the ones they wish to view from this catalogue. This means it is not done systematically. This might confuse students who do not have a good understanding of the basic knowledge of the chapter.
- Restriction to labelling ie by two different colour arrows, is insufficient. If students are viewing sections, they firstly need to be orientated in the section, and then informed about certain structures. Two arrows are definitely not sufficient for this kind of information. Labelling of structures would be a better way to help students identify the structures they are viewing.
- An image information box is good for lecturers but it would have more relevance if this box could have a glossary to the text, which could possibly explain certain names and terms to students, which they might not understand.

HUMAN HISTOLOGY

DESCRIPTION

This disc contains an image library of 812 images from Stevens & Lowe/Human Histology Second Edition. These images can be searched by category of keyword. This program gives the viewer an opportunity to use the program as is or create their own slide shows by using the Slide Show Building facility offered in the program. Captions can also be added to slides in the program, as well as extra labels. There is also a Quiz Builder, with over 180 multiple-choice

questions arranged by category and saved in 18 quizzes. New questions, based on the images used, can be created in the Image Library.

The opening screen of this program presents one with a choice of slide shows and quizzes. Once a chapter is chosen, the student clicks on a "view" button to be taken to the chapter indicated. There is a set of controls on the floating navigation bar to allow students to move through the slides. Captions (text) can be moved and sized, as well as closed to allow students to view the entire slide.

The quizzes come in the form of multiple-choice questions. Immediate feedback is given to students. At the end of the quiz, the program will compile a report detailing the overall score.

STRENGTH OF THE PROGRAM

- Micrographs are clearly labelled, which helps students to orientate themselves as well as identify the structures. These labels are also referred to in the text.
- Schematic drawings added to chapters make them very illustrative and help with extra information, especially when it comes to structural-functional relationships.
- Multiple-choice questions are a good way of testing the students and immediate feedback allows students to ascertain how well they have mastered the module. This fact is enhanced by the overall scoring system, which gives students their marks at the end of the quiz.

THE WEAKNESS OF THE PROGRAM

- The first chapter called "Histology – don't switch off" is very confusing and has no relevance to the rest of the chapters. This might cause confusion with the students as well.
- There is an over-lapping of captions and images which mean that both cannot be seen together, that is everything on the page cannot be seen at the same time.
- The box for text is very small, and the text is in great detail, therefore scrolling up and down makes it difficult to read all at once and therefore makes it difficult to create an easy understanding of the micrograph or schematic drawing on display.

- Most of the text is structural-functional orientated and therefore, descriptions are more physiological than histological, which is good for general knowledge but is of less importance when it comes to the histology course for dentistry students. This also means that students have to have a good basic understanding of histology before they can be able to use the modules of this program.
- There is also the time constraint as explained earlier, because of the amount of detail, students are going to need quite a bit of time on computer to cover the module they are revising.

CONCLUSION

None of these commercial programs met all the requirements needed for the histology course of the second year dentistry students in the Anatomy Department of the University of the Western Cape. Two were taken directly from textbooks, the department has the textbooks, and therefore too informative, which is good for a textbook but not for a computer program, which students are using for revision and have limited time to use. The third program did not allow for easy progress through it, and was also not informative enough to create a clear understanding about the modules second year dentistry students have to master in histology.

This initiated the research to develop programs in microanatomy with relevance to the curriculum of the second year dentistry students, to enhance the histology course and allow them an opportunity to revise modules in their own time, when they can and with little, and if possible, no assistance during revision. Therefore these programs need to be student friendly, ie easy to use, with relevant information and well-labeled micrographs, helping to create a clear understanding of the module.

Through assessing the three programs and recording the strengths and weaknesses, it is hoped that the evaluation done on this thesis would illustrate that none of these programs would be able to be used effectively for the particular purpose needed to assist the dental students, of the Anatomy Department of the University of the Western Cape in order for them to master modules needed for the histology course and also to address several problems encountered when teaching the course.

Being aware that all commercial programs would have their strengths and weaknesses and that no one program would be able to meet all the needs of a particular course or class, it was decided to develop an 'in-house' computer based program .

CHAPTER 5

MOTIVATION FOR DEVELOPING AND DESIGNING THE PROGRAMS

" Since 1950, behavioural psychologists have produced an impressive amount of basic research directed at understanding how various forms of behaviour are developed and maintained. These studies have included:

- The interaction preceding behaviour, such as attention span and perceptual processes.
- Changes in behaviour itself, such as formation skills.
- Interactions following behaviour such as the effects of incentives or rewards and punishments." (Microsoft Encarta Encyclopedia 2001)

For the purpose of this study, two approaches to student learning are discussed.

The belief that one cannot observe learning except through behavioural changes is an important behaviourist concept. Behaviourist learning theory believes that the product or outcome is the most important factor to consider i.e. the results of final examinations. Much of the research was done on animals rather than human learners and later tested on humans. The important components of a behaviourist theorist are stimulus, response and reinforcement.

For many years the behaviourist learning theory was used for the development of curriculum and lecturing processes in the Anatomy Department of the University of the Western Cape, as well of other departments of the university e.g. the final results of students being positive was the most important factor, ie students needed to pass the course at the end of the year.

In contrast to the behaviourist theories, the cognitivist theories are directly concerned with how we learn and what goes on inside a learner's mind. According to Goodwin (2001) the characteristics of this theory in comparison to a behaviourist theory are:

- Behaviourists feel students learn by direct instruction while cognitivists believe that they learn by discovery.
- Behaviourist focuses more on product/outcomes while cognitivists focuse more on the process.

- Behaviourists are future orientated while cognitivists are present orientated.
- Motivation for behaviourist theory is external while for cognitivist it is networking.
- When developing curriculum or studying processes the focus for a behaviourist is academic and basic while the cognitivist focus is more holistic
- Accountability is also very important for the behaviourist while the cognitivist would leave the choice to the student.

It is also clear that the cognitivists have drawn on behaviourist theory and incorporated it into their own models. This theory focuses more on:

- How students retain information rather than what they retain
- Stressing that learning materials should be well organized.
- New ideas and concepts when added to the chapter or course must be meaningful and relevant to the module and learner.
- New concepts need to be added continuously to the basics which will help students with retrieval and retention of information.

These cognitivist learning principle also form the basis of constructivist theory.
Constructivism is learner centered and is focused on how the learner constructs knowledge from experience, which is unique to each person and built upon prior experience.

These theorists view the student as one who acts on objects and events within his/her environment, thereby gaining some understanding of the features held by the object or event. The emphasis is placed on the student rather than the course. The student's individual development is at the center of instruction. This changes a lecturer's role from dictator to a facilitator who assists students to construct their own concepts.

Lev Vygotsky, a Russian psychologist and philosopher is often associated with the constructivist theory. According to Vygotsky, social interaction is fundamental to learning. He emphasizes that learning and development is a social and collaborative activity that cannot be "taught" to anyone. It is up to the student to construct her own understanding in her own mind and during this process the lecturer will act as the facilitator.

Another cognitive constructivist of the 1920s is Jean Piaget, a Swiss psychologist who focused on the study of human development. His theories are more holistic in that they place learning as an experience resulting from the perceptual whole rather than the individual stimuli. He believes that learning takes place through several channels, viz. listening, exploring and experiencing. He claims that using all of the channels helps one to learn logically, gaining a general understanding.

This theory of cognitive development proposes that students cannot be 'given' information, which they immediately understand, and use. They must be helped to construct their own knowledge. "They will then actively take this knowledge, connect it to previously assimilated knowledge and made it theirs by constructing their own interpretation." (Hanley, 1994)

An eighteenth century Neapolitan philosopher, Giambattista Vico, claims that one only knows something if one can explain it. He goes on to say that humans can only clearly understand what they themselves have constructed. Piaget supported this theory. He also believed that the fundamentals of learning is discovery and should be encouraged in the learning process, if we want students to be creative and productive and not simply repetitive.

Learning theorists also believe that there are a series of events that should satisfy or provide conditions for learning and serve as a basis for designing instruction and selecting appropriate media (Moonley et al, 1992).

One of the appropriate forms of media is computer-assisted instruction. Technological support of this form can definitely help to provide a learning environment that aids in expanding the conceptual and experiential backgrounds of a student.

This form of technology can also provide tools with which to accomplish the goals of the cognitivist/constructivist theory.

These theorists also identify certain prerequisites that should be completed to facilitate learning a task, module or course. They are known as Gagne's Nine Events and these learning prerequisites provide the basis for sequencing instruction. They are:

1. Reception (gaining attention)
2. Expectancy (informing learners of the objectives)
3. Retrieval (stimulating recall of prior learning)
4. Selective perception (presenting the stimulus)
5. Semantic encoding (providing learning guidance)
6. Responding (eliciting performance)
7. Reinforcement (providing feedback)
8. Retrieval (assessing performance)
9. Generalisation (enhancing retention and transfer)

The following prerequisites were considered when designing and developing the histology programs for second year dentistry students using the combined knowledge of the lecturer, designer and the programs. The lecturer provides the material of the system or chapter that has to be developed. The designer uses this information to develop the instructional objectives and lesson designs and the programmer focuses on the screen designs and the navigational tools.

1. RECEPTION (gaining attention)

The first objective is to gain the students immediate interest in the program and the course. Attractive relevant images are used on all the pages of the program i.e. the cover page, content page, menu, etc. This helps to keep the student's attention throughout the program (Fig.1).

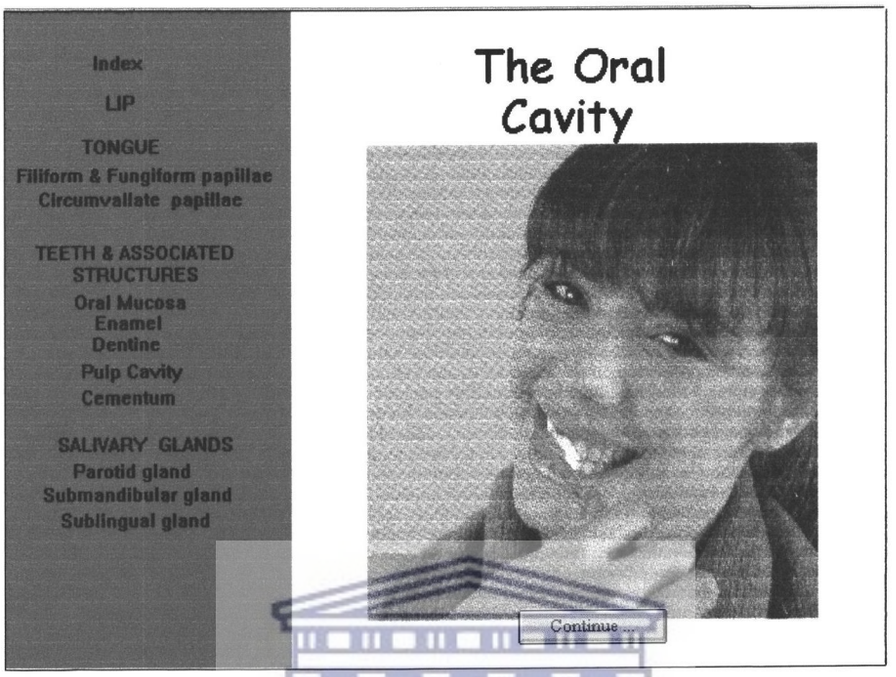


Figure 1: The cover page of the oral cavity.

There is also the realization that the layout of the screen is very important. The way the program appears to the students and is presented to them helps to communicate with the learner. The pages need to be simple and uncluttered. The program should also give the learner clear directions on how to use and work through the program. The program should also invite the learner to interact with it therefore encouraging and enhancing deeper levels of knowledge acquisition and construction (Fig.2).

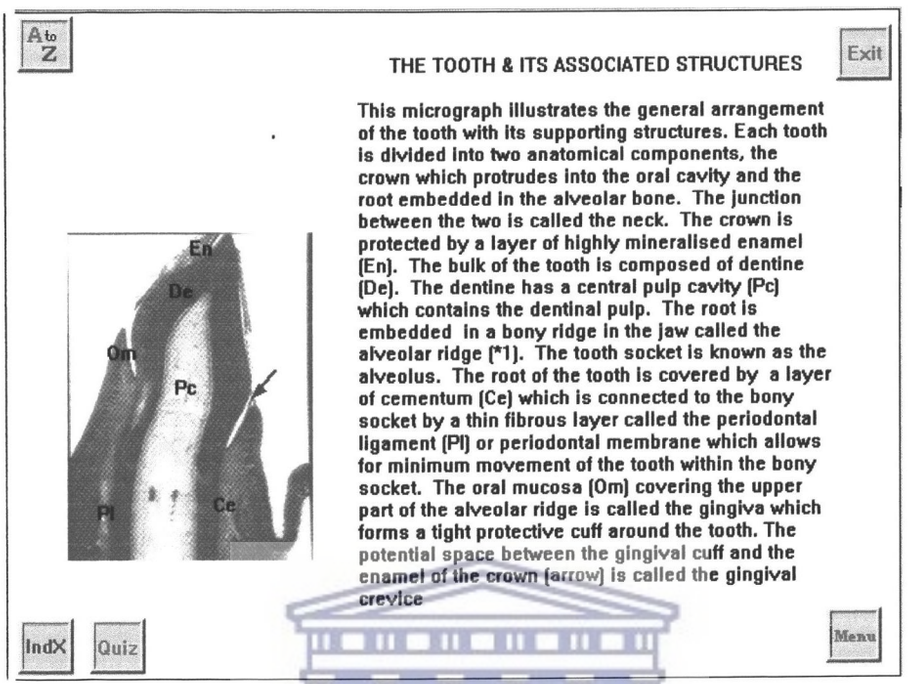


Figure 2: The teeth and associated structures.

D H Jonassen, a nineteenth century learning theorist supported this by claiming that the integration of learning strategies in computer-based courseware facilitated deeper levels of cognitive processing of knowledge.

2. EXPECTANCY (informing learners of the objectives)

There is an index at the beginning of each module informing students how many components the modules contain (Fig.3).

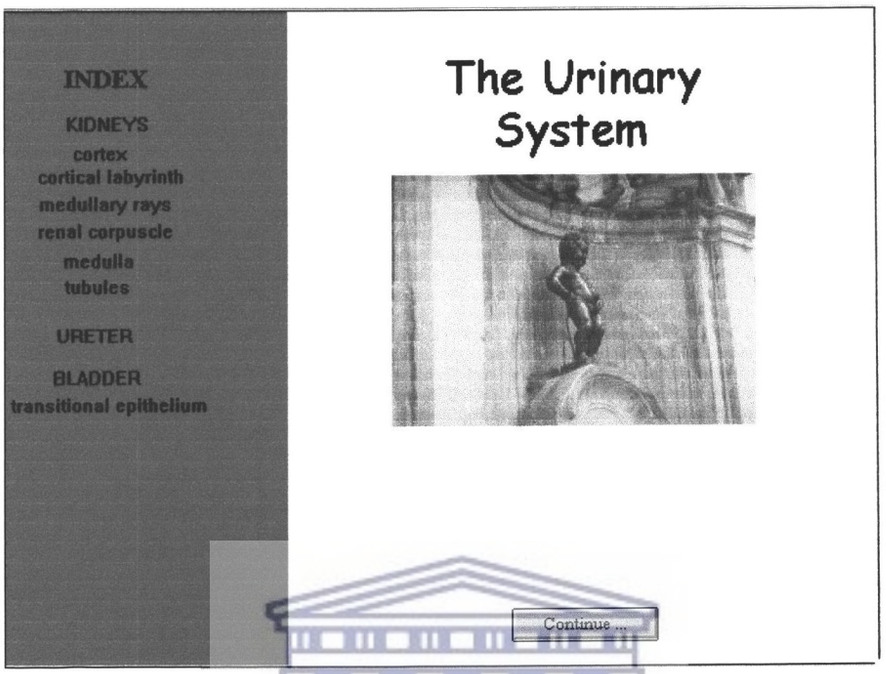


Figure 3: The cover page of the urinary system.

There is also a well-constructed anatomical menu in the form of an image to orientate students and also assist them in integrating anatomy with histology (microanatomy) (Fig.4).

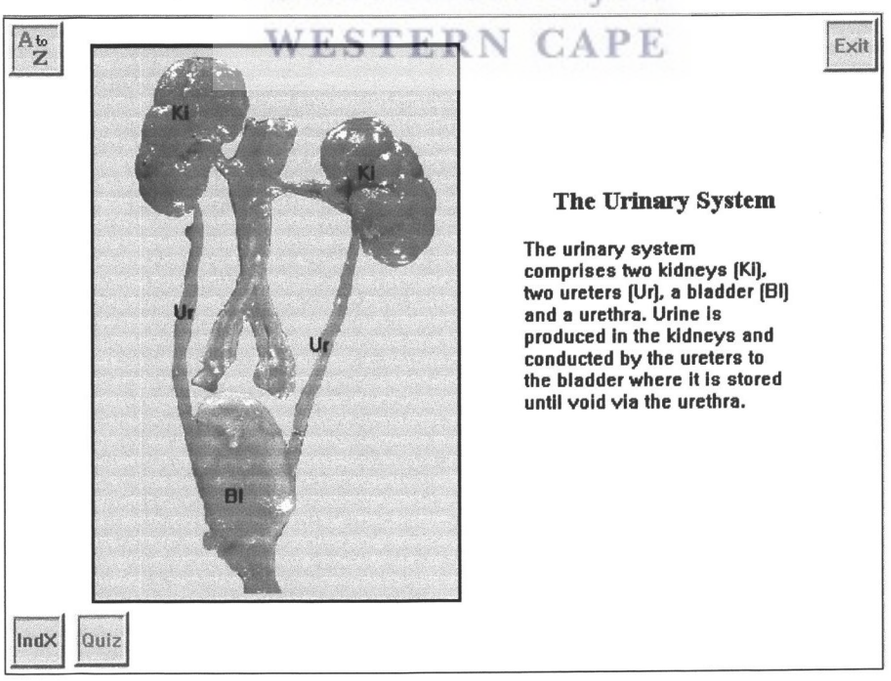


Figure 4: The menu of the urinary system

3. RETRIEVAL (stimulating recall of prior learning)

Students come into the classroom with their own experiences and a cognitive structure based on those experiences.

The module is introduced with a well-illustrated descriptive menu of an anatomical image of the system, which helps students revise the basic structures of the system they have learnt (Fig.5).

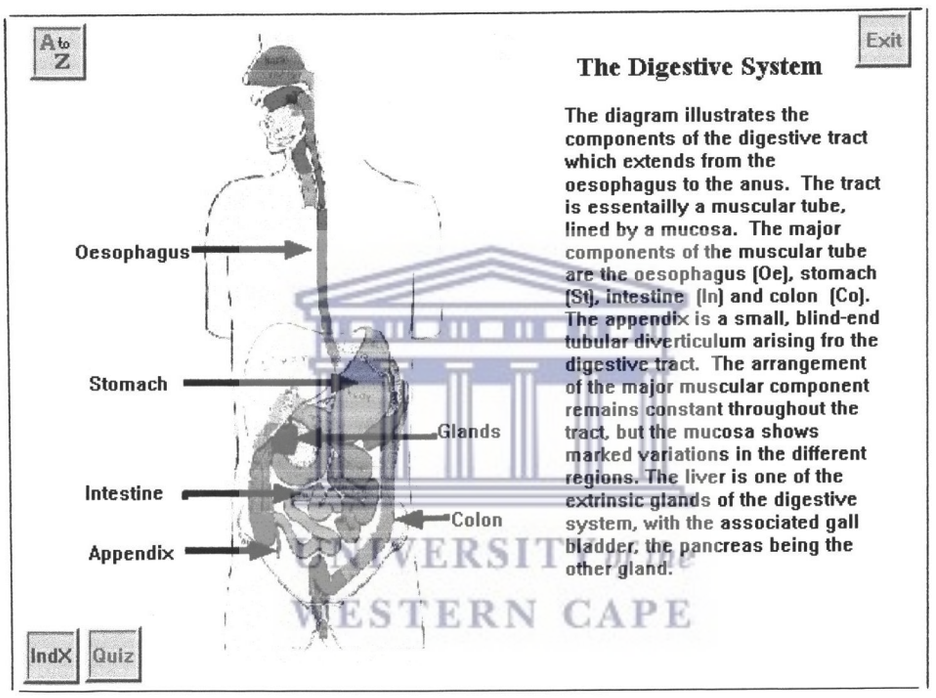


Figure 5: The menu of digestive system.

4. SELECTIVE PERCEPTION (providing the stimulus)

The program contains many colourful images of the systems, which students need to revise, and added text, which orientates them, and explains the relevant components of the images. The components of the images are labeled (Fig.6). By clicking on the appropriate component an image of that appendage or layer is called up under higher magnification, allowing students to obtain more detail about the various microanatomical sections of the system (Fig.6 and Fig. 7).

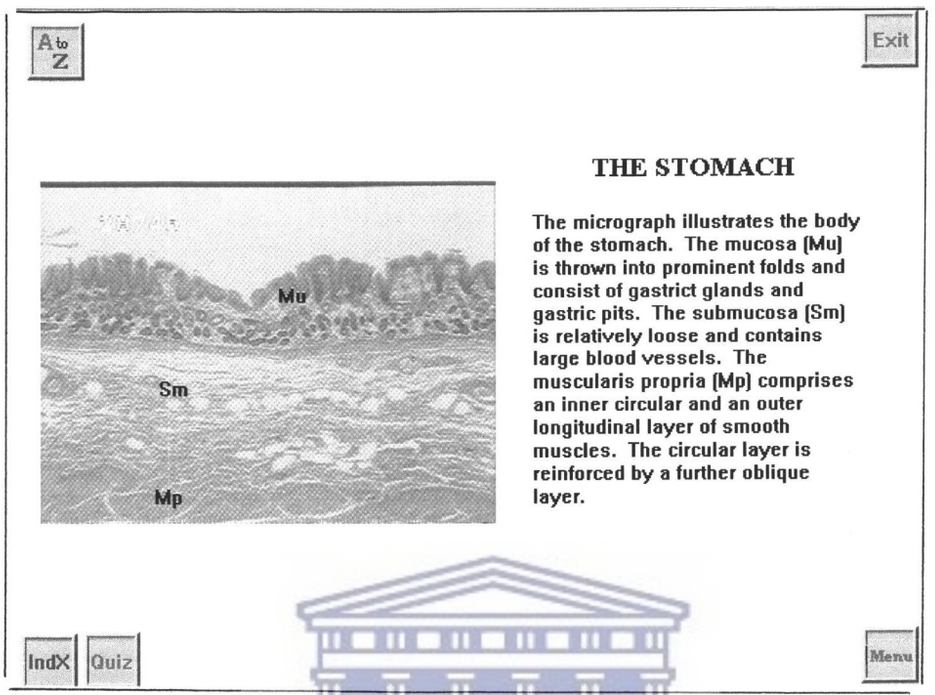


Figure 6: The stomach.

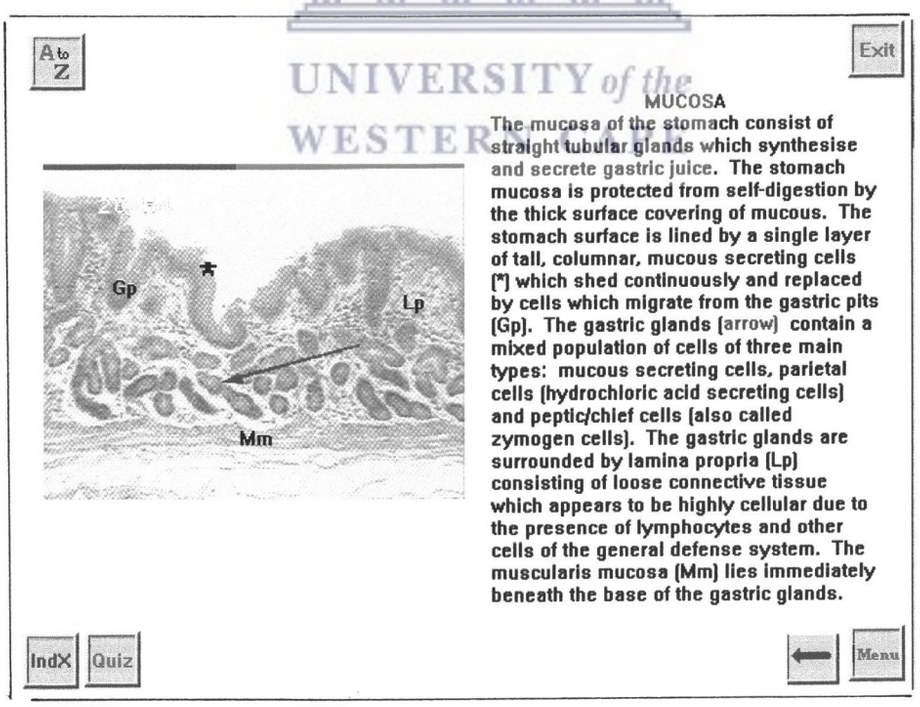


Figure 7: The mucosa of the stomach.

5. RESPONDING (eliciting performance)

When students use the program, they are allowed several routes to follow to master the module. They are given the menu and have a choice as to what order they would like to study the module and also how much depth they would like to cover on that system (Fig.8).

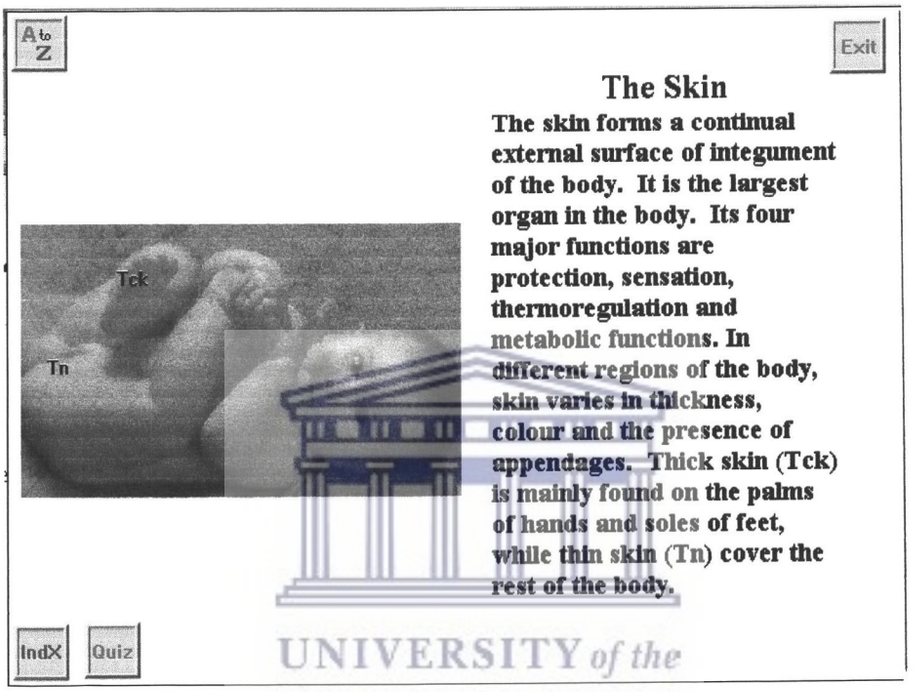


Figure 8: They have an option to learn either thick or thin skin.

6. RETRIEVAL (assessing performance)

There are tests linked to each module with relevant images of the system and questions on the images which students are encouraged to answer.

Once student have mastered the program they are afforded an opportunity to link to a test on the system, allowing them to assess whether they have mastered the chapter or not.

The test has all the images of the program with relevant questions about each image (Fig.9).

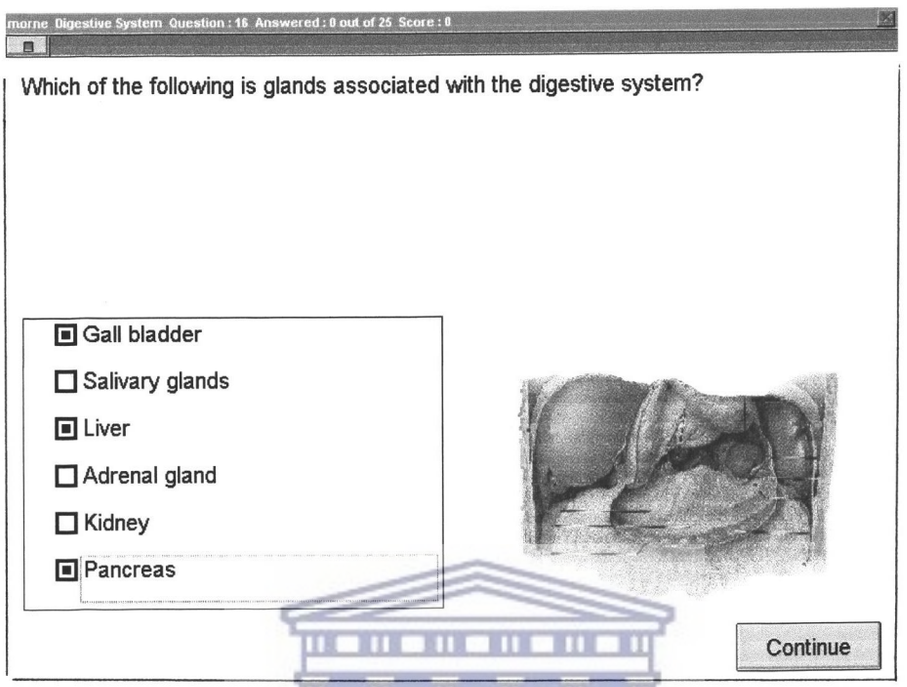


Figure 9: The testing system.

According to Munden (1996), computer based learning should be designed and produced by Instructional Design Teams. Each member of the team is a specialist, but when working together and following procedures developed by the group, they can produce efficient, effective instruction for a variety of outcomes, learners and media. The following should be members of the team:

- knowledge expert
- designer of the program
- programmer

Each member has special skills and activities to donate towards the program.

1. THE KNOWLEDGE EXPERT is a person, or group of people who know the material or content to be conveyed to the learner. This person works closely with the designer in planning the lesson. He/she can analyse the learning task, determine educational outcomes and develop lesson objectives, as well as provide the content of the lesson.
2. THE DESIGNER OF THE PROGRAM helps to develop instructional objectives, determines the most appropriate lesson designs and determines what the screen design

should look like. He/she may also perform other tasks that may be needed in the planning and organizing stages.

3. THE PROGRAMMER develops the various screens and navigational tools according to what the designer and knowledge expert have agreed upon. This member makes sure the program runs in the order it is supposed to run. Also graphics, sounds and video clips used to enhance the program would be developed , captured and scanned in by the programmer.

It would be also advisable to have an evaluator as part of the team. The evaluator would determine if the lesson, chapter or program is effective. Also if the program teaches specific skills, the evaluator will appropriate the levels determined by the knowledge expert.

Both formative and summative evaluation should be performed on the program:

- Formative evaluation would take place during the development of the product. It would assist in finding any problems with the lesson features that require modification so that changes may be implemented.
- Summative evaluation would be used to determine the value of the lesson after it has been developed. The focus of this assessment is not lesson content or procedural modification, but is used to make decisions regarding the effectiveness of the program.

CHAPTER 6

COMPUTER LITERACY QUESTIONNAIRE

Of the 42 second year dental students of the Anatomy department of the University of the Western Cape, who used the program, 41 were available to answer the computer literacy questionnaire, which was handed out to students during the course of the year before they were introduced to any computer assisted instruction programs.

The idea of this evaluation was not just to examine learning outcomes, but also to examine the bigger picture. There is a need to look at cultural aspects, language and attitudes to computers. There was a need to ascertained if potential users have access and requisite skills. Therefore the following questionnaire was given to all students who were going to use the program and they had to complete it before they could use the program.

BACKGROUND INFORMATION

1. GENDER

MALE	19
FEMALE	22

2. AGE BETWEEN

15 – 19	11
20 – 24	25
25 – 29	5
30 +	

3. IS ENGLISH YOUR FIRST LANGUAGE:

YES	20
NO	21

4. MARITAL STATUS

Single	40
Married	1
Divorced	

5. ARE YOU STAYING:

Resident on campus	20
Off campus with friends	3
Off campus with family	16
Off campus – own home	1

6. DO YOU HAVE A CELLULAR PHONE

YES	36
NO	5

7. DO YOU HAVE A TELEPHONE AT HOME

YES	34
NO	7

8. DO YOU HAVE YOU OWN COMPUTER

YES	11
NO	30

9. EXPECTATION AND FEELINGS ABOUT LEARNING MODES AND PROCESSES

SA = Strongly agree

A = Agree

N = Neutral

D = Disagree

SD = Strongly disagree

	SA	A	N	D	SD
I like to read	16	16	8		
Learning is an enjoyable experience	15	22	4		
My friends think that I am well organized	5	20	13	2	
I tend to put things off till the last minute	4	15	13	3	6
I like working on my own	18	13	7	3	
I like doing tutorials	4	16	14	2	5
I like working on the computer	21	11	6	3	
I like working on-line (web browser)	17	9	11	4	
I work regularly each week on this course (histo)	3	11	18	7	2
This course is important for my future career (histo)	21	14	6		

10. YOUR PREVIOUS EXPERIENCE WITH COMPUTERS

Novice (N) – I seldom or never use

Occasionally – a few times a month

Frequently – once or twice a week

Daily

	Novice	Occasionally	Frequently	Daily
Personal computer	11	14	10	5
Printer	7	25	7	1
Email	10	8	16	6
Word processor	6	18	15	1
Web browser	9	15	12	4

11. CURRENT FEELINGS ABOUT COMPUTERS

Stimulating	25	Somewhat stimulating	14	Somewhat dull		Dull	
Fun	28	Somewhat fun	13	Somewhat dreary		Dreary	
Easy	12	Somewhat easy	20	Somewhat difficult	7	Difficult	
Hindering		Somewhat hindering	1	Somewhat helpful	13	Helpful	25
Threatening	1	Somewhat threatening	3	Somewhat enjoyable	9	Enjoyable	27

About half of the class was male and half female and the majority ranged between the ages of 19 and 24. About 5 were slightly older.

Half of the class indicated that English was their second language, which immediately put them at a disadvantage when studying medical subjects with the large curriculum and difficult terminology. The question on their marital status was to check if any of the students had extra responsibilities at home, which might have affected their studies and therefore affected their results.

Half of them were resident on campus, which meant that they had easy access to computers all the time while the other half who stayed off campus had personal computers or access to a computer where they stayed.

Most of the students enjoyed reading and did not have a problem with studying. Most of them preferred doing tutorials and preferred to work on their own. They enjoyed working with computers even web-browsers.

More than half of the class use the computer frequently i.e. at least once or twice a week for word processing, email, internet etc.

The questionnaire showed that more than 90% of the class found using the computer stimulating, helpful, fun and easy to use. Attitudes to computer-assisted learning are important because it has a direct relation to computer confidence.

Less than 10% found it difficult to operate and only 4 students in the class was threatened by using the computer.

Students were then afforded an opportunity during their tutorial time to use several commercial programs that were purchased by the department.

And their comments, during interviews with them after they had used the programs were:

- The program is too difficult to use. Half the tutorial time was used showing them how to use the program.
- Some of the images were not clear.
- There was too much text.
- One program was said to be a "histology dictionary" and did not help them understand the modules or systems they were studying.
- One of the programs was just an electronic textbook, which could have been read in hard copy.

They were then given an opportunity to use the local programs that had been developed in the department and a questionnaire to evaluate the programs, which also had a glossary and a self-testing system.

EVALUATION OF COMPUTER PROGRAM

The introduction of innovative curricula means that different ways must be found to assess students and evaluate courses and programs. Measuring the effectiveness of the programs undergoing change is essential as a way of continuously improving teaching and learning.

It is important that assessment tools be specific to the knowledge, skills and attitudes being assessed. They must also measure reliability, validity and acceptability and be consistent with the educational principles and objectives of the curriculum.

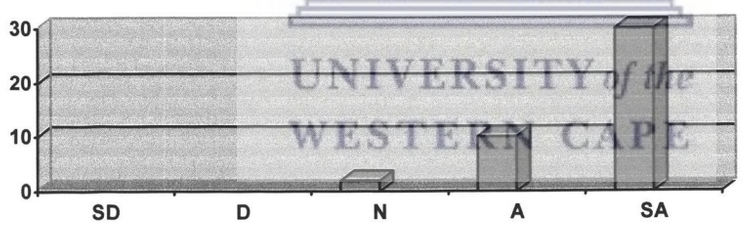
The following questionnaire was handed to students after they had completed the programs. To encourage honesty they did not have to fill in their names or students numbers.

REVISION PROGRAM

This is a new way for students to revise a module. Seven questions were asked to see how students felt about revising histology using the program. 42 students assessed it as follows.

RESULTS OF THE QUESTIONNAIRE

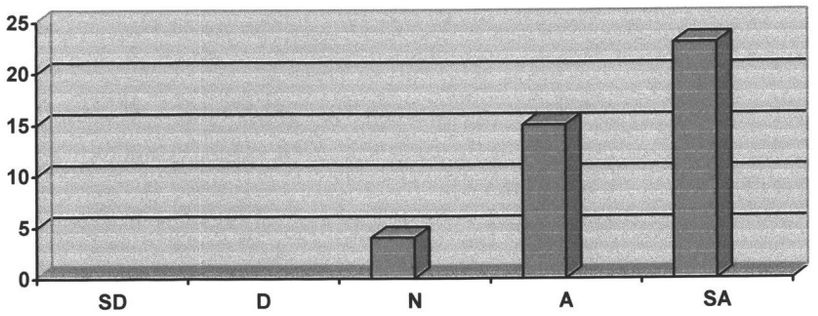
QUESTION 1 – This is an interesting way of learning histology.



SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

These results show that all of the class except for two find this an interesting way to study. Students were given a time during a tutorial to use the program and many of them stayed long after the time allocated for the tutorial and also asked to come in several more times to use the program.

QUESTION 2 - This program helped me understand the topic better.



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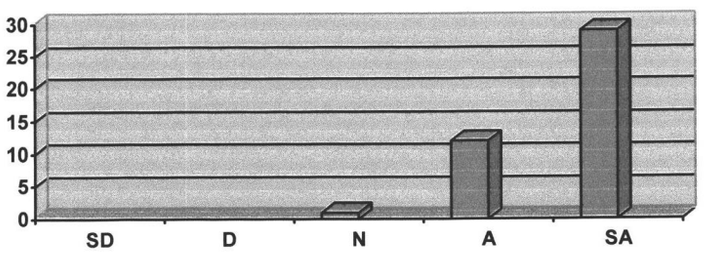
They were given an opportunity to work on each program as long and as often as they wanted to. 90% of the class agreed that the program definitely assisted them in gaining a better understanding of the systems of the body and the general results showed that the class average changed from 55% to 62%.

QUESTION 3 – The labeled images gave me a better understanding of the components of images and where they are found.



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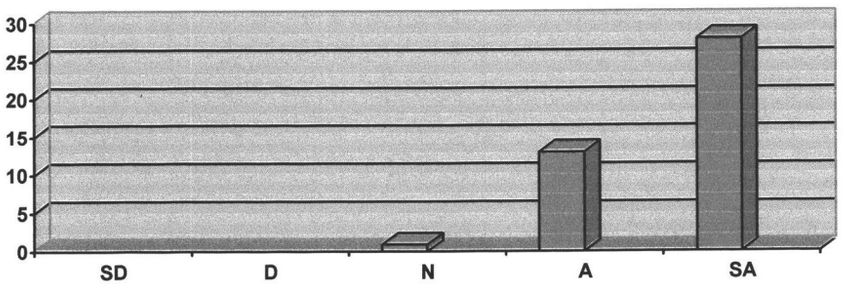
98% of the students felt that the labeled images with added text help them to orientate themselves in the light micrograph and also helped them to identify structures, which they would not have been able to identify when looking down a microscope.

QUESTION 4 – The text added to the image helped me relate theory (lesson in class) to practical (images on screen)



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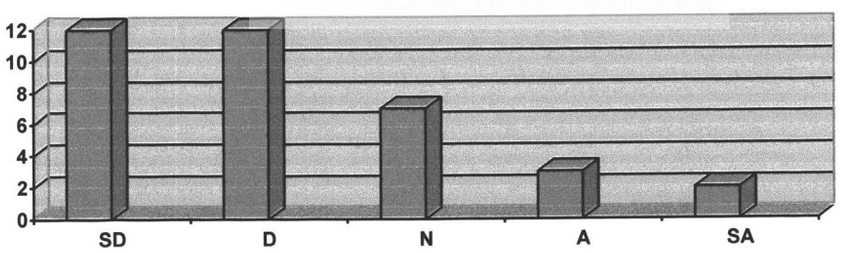
Students find it difficult to integrate the lecture notes to the images they have to view in the practical. In the program the text of the lecture is added to the same screen with the images they have to identify in the practicals and tutorials. The images are also labeled (abbreviated in text) which helps them integrate the lecture with the practical.

QUESTION 5 – There are too much text to images

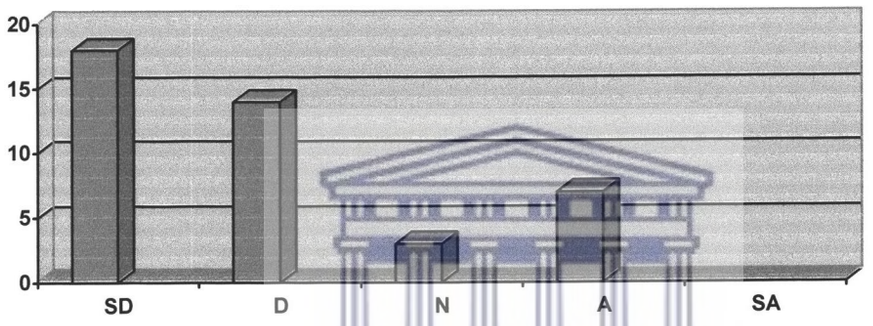


SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

This question was asked to assess if the information given about the micrographs might not have too much text therefore forcing students to spend too much time reading all the text. Also realizing that at least half the class has English as a second language. 71% of the class felt that the text was not too much. 17% was not sure what too much text meant but 12% of the class felt that they did find the text too much. These students did indicate that English was their second language and that they also had problems with terminology and they felt that if sound was added

to the program and the text could be read it would really make it easier to go through the program and also more enjoyable doing it. There are facilities in Authorware to allow for this. Authorware is a computer program which assists computer-developers in constructing multimedia computer-based instruction programs.

QUESTION 6 - Using the computer took too much time; it was easier reading a textbook.



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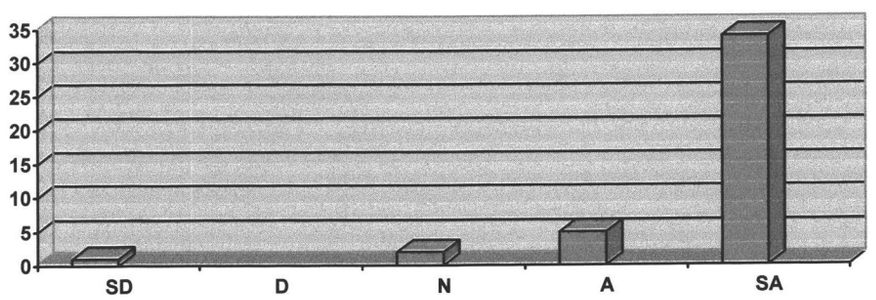
The reason for this question was to compare written pages with electronic ones, to see which students preferred. 76% of the class did not agree. They preferred working through the program to reading the chapter in a book. 7% was not sure what they preferred and the 17% who preferred the book were possibly those who were threatened by computers.

QUESTION 7 – It was good to revise using the program at my own pace and in my own time



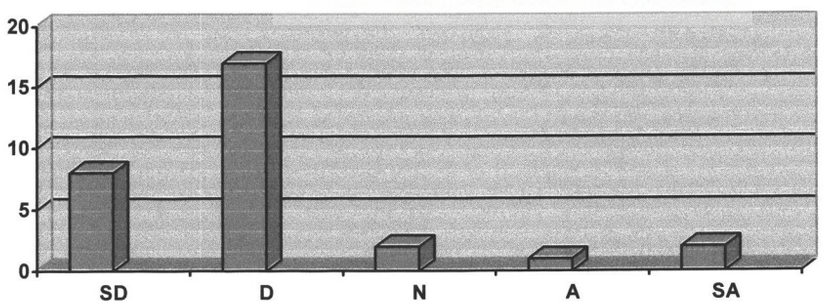
SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

In the previous questionnaire more that 90% of the class indicated that they enjoyed using computers as a means of studying. They also enjoyed doing tutorials and working on their own. Once again answering this question 93% of the class indicated that they enjoyed using this program to revise on their own. During the tutorial time, when they were using the program there were two tutors in the room to assist students if they had any problems or questions and only two students asked for assistance with a software problem but no one had problems with the program itself.

SELF-TESTING PROGAM

It was the first time students have done a test in computer format. The questionnaire was to assess how students felt using this new format, which is similar to the traditional "spot test" i.e. practical examination, and to see if they did not have a problem with terminology or identification of micrographs. 42 students used the self-testing program but only 30 students filled in the questionnaire.

QUESTION 1 – The questions were not very specific and clearly stated.

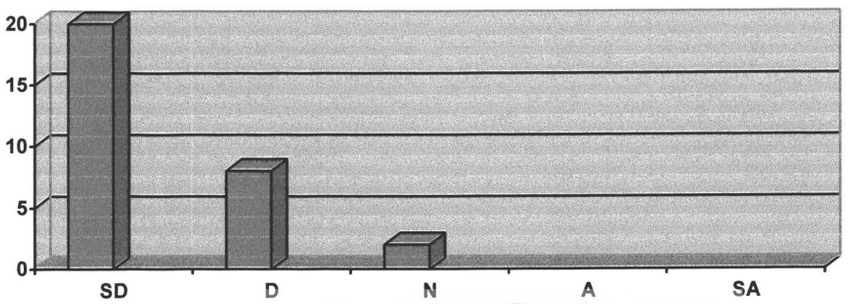


SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

This question was asked to make sure that students see the relevance of the questions and that if they did poorly in the test it was not because they did not understand the questions. This was also the information they needed to know to understand each chapter. 83% of the students felt that they understood the questions, 6% was not sure and 10% had a problem with the questions which

are the students who have English as a second language and have problems understanding some of the terminology.

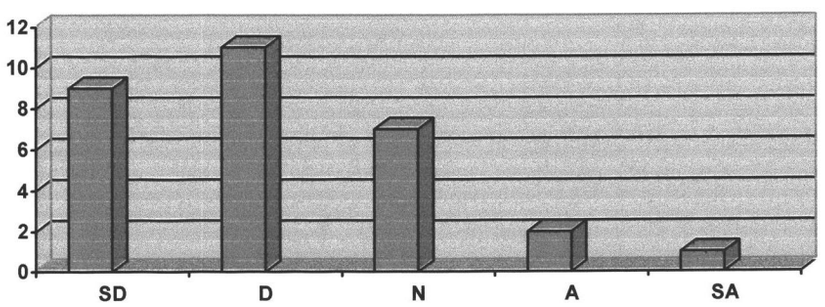
QUESTION 2 – The questions did not relate to the subject



SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

The questions were set to help students to integrate the theory with the practical and it needed to be assess whether they understood the relevance to the chapter they were studying. 93% could see the relevance, while the other 7% who are only 2 students was not quite sure.

QUESTION 3 – Multiple choice questions are very difficult to answer

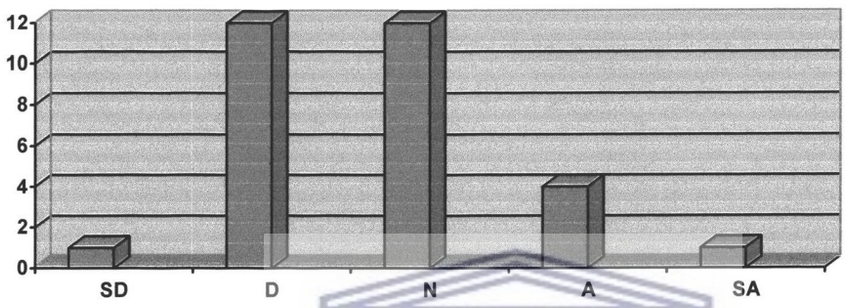


SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

The answers were one-word answers but they could be one, two, three or even four correct ones. This format did not allow students to guess and some questions even asked that the answers be put in the correct order. We had to see that if there were poor results, it was not because students

had a problem with the type of questions asked. 67% did not have a problem with the questions, 23% were neutral and the rest, which was 3 students had a problem with the way these questions had to be answered and once again it was the students that were threatened by using computers.

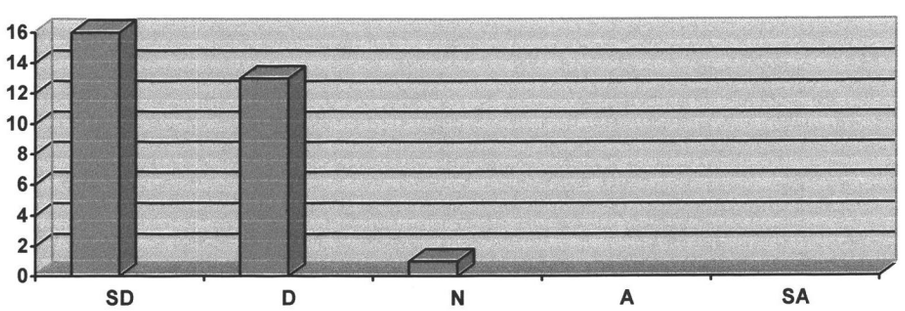
QUESTION 4 – Overall the questions were too easy



SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

These were the same type of questions that would be asked in a class test and in final examinations. This question was just to assess if students had mastered the module (chapter). 43% were happy with the questions, 40% were not sure what the word easy meant, and 17% agreed that the questions were too easy, but these were the top students in the class.

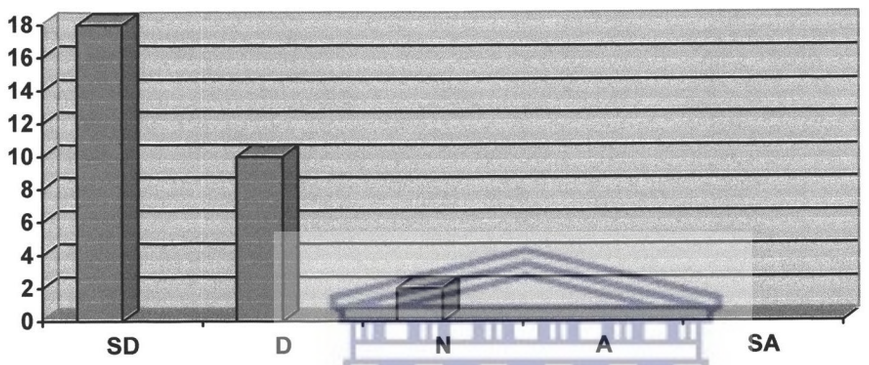
QUESTION 5 – The images did not relate to the questions.



SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

Part of the testing was to make sure that students could now integrate theory into practicals (images) that they understood what they saw under the microscopes. 97%, which was all students, except 1, could now understand what they saw under the microscope.

QUESTION 6 – Adding images to the questions are very confusing



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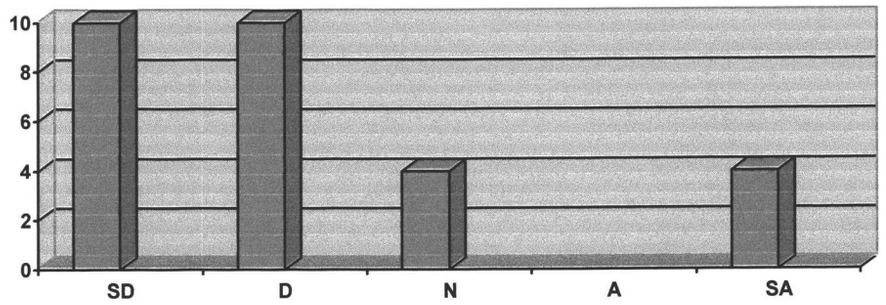
This was once again a means of assessing if students had the ability to integrate theory with practicals and not see them as separate entities, but bring what they have learnt in the lecture into the practical room and use it when looking down a microscope. All the students except two could manage this after they had mastered the modules.

GENERAL ASSESSMENT OF THE FULL PROGRAMS

These questions were to assess how students felt about this new way of revising modules in histology. Although 42 students used the program only 28 students completed this section of the questionnaire.

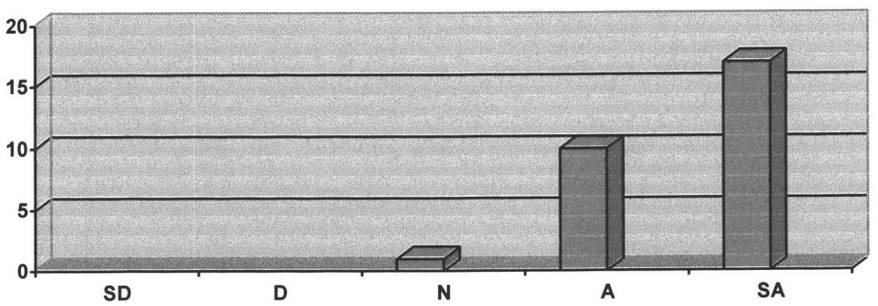
QUESTION 1 – This program only adds more work to an already "fully" structured course



SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

Realising that the medical curriculum is so overloaded, one did not want students to feel that these programs would only be adding more work to an already overloaded curriculum. 71% of the students were happy to add this new form of revision to their program, 14% were neutral and the rest who are only 4 students did feel threatened by this new format of revision.

QUESTION 2 – Studying the modules this way helps me integrate theory (learnt in a lecture) with practicals (images seen in a microscope)

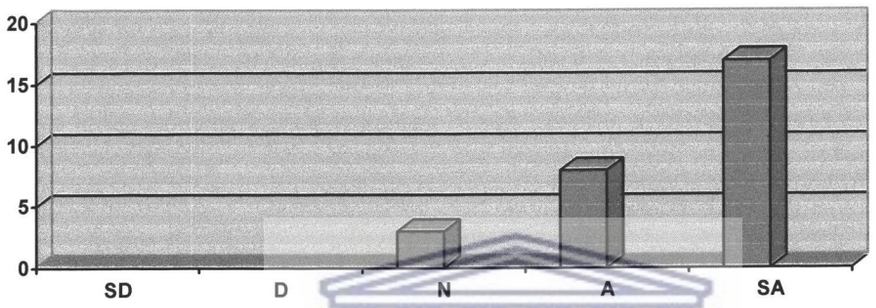


SD = Strongly disagree D = disagree N = Neutral A = Agree SA = Strongly agree

This was one of the problems we had with teaching medical students the histology course and one of the reasons why students did so badly in their practical examinations. Results show that 96%

i.e. all the students except 1 who was neutral, had overcome this problem and their final results confirmed this.

QUESTION 3 – Students will require less supervision when revising the various systems by using these programs.



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One of the problems encountered in practicals is that there are 42 students to one lecturer and one tutor. Students need assistance with identification and orientation all the time and many times they have to go without assistance because two people cannot cope. When they were using the computer program there were also two assistants, one technical and one to help with the course work but during the whole tutorial only two students asked for assistance and that was to help with the software of the program. These results show that this is one way to overcome the problem of large classes and a shortage of staff or tutors.

DISCUSSION ON THE RESULTS

REVISION PROGRAM

Students often feel that histology is a boring subject. Most of the time it is because of the passive way they have to learn the subject. The idea behind developing this courseware and testware was to gain the interest of students by moving them from passive recipients of information to active participants in knowledge construction, that is to get them to interact with the module while they are revising (Whittaker, 1989). Most students were definitely interested, although there were a few who did not share the enthusiasm, claiming they were traumatized by using technology for

the first time. They needed more time to acquaint themselves with the program before the actual testing.

For the students there is such a short time to assimilate an immense amount of knowledge. The lecturer has to go at a pace that will allow him/her to complete the syllabus. The time capacity used for learning a particular module differs from one student to the next. The program was designed to give students the opportunity to revise the module as often as they please, taking as long as they need. The results have been very positive, and many students made use of the opportunity to master the module at their own pace.

Microscope slides are not labeled and therefore students have to depend on lecturers, tutors and atlases to assist with identification (Alper, 1992). This program was so designed to allow students to revise with less assistance, and if possible no assistance at all. Therefore the structures of the images were labeled allowing students to easily find the various components in the micrograph. These labels were incorporated into the text as well, to help them to relate the two. The results showed that most students agreed that the labeled images gave them a better understanding of the components and helped them to orientate themselves in the micrograph, ie the section on the slide.

One of the main problems in histology is that student cannot integrate theory (the lectures) with the practical (sections viewed in a microscope). The program was designed to combine a concise text and glossary with relevant fully labeled micrographs, therefore trying to assist students with this problem. The results show that most of the students feel that the program has managed to accomplish this objective.

There was a concern though about the amount of text one should put on an image, being very aware that students were learning it from the computer and realizing that today's students demand information (text) that is easy to read yet sufficiently detailed to satisfy examination requirements. The text also needed to have a "user-friendly" well-designed layout and the material needed to be presented in an attractive way. Therefore in the text, lengthy introductions were avoided with the assumption that at this stage students would have acquired some basic knowledge of the module

in the lecture. The results showed that most students felt that the text was adequate. It is possible that the few students that did not agree did not gain that basic understanding in the lecture.

This program was designed to enhance the course and not replace it therefore students were expected to use it as an "educational tool" to their course (Whittaker, 1989). There was a fear that this would be too much for an already 'heavy' course. However, the results showed that almost all the students felt that this was not so. The mixed feelings that some of the students had could be because they were not very comfortable with using the computer and therefore it took much longer for them to use the program.

Another objective of this program was to encourage individualized instruction. The design of this module was based on mastery learning followed by a diagnostic test of the student's knowledge. For the slower learner this revision program could be used as an opportunity to learn at his/her own pace and assess his/her own performance. The students could therefore discipline themselves to master each module at their own pace (Spencer, 1990). The results show that students agreed that this program has definitely helped them in this respect.

THE SELF-TESTING PROGRAM

Often when students do badly in a test one wonders if it was because they did not understand the histology questions and therefore they answered them incorrectly. To make sure that the questions used were understood, statements relating to the relevance of the questions were used for this section of the questionnaire. The questions were formulated in such a way as to cover the important aspect of a module, which the lecturer cannot stress enough during the lecture. In the revision program these issues were emphasized. The results show that most students felt that the questions were specific and all the students agreed that they were relevant to the module. Time did not allow me to find out if those who disagreed did so because of the specificity of the questions, or because of the time limit they were not able to master the module and therefore did not understand some of the questions.

The questions for the self-testing program required one or two word answers, but needed detailed revision to gain the required knowledge. However because all students do not take the same

amount of time to master a module and because the project had a time limit for testing, there was a chance that some of the students might not have been able to master all the modules in time. Some of the results could possibly be a confirmation of this. If students were allowed to use the program till they had mastered the module they might have felt differently. We also needed to check with the students whether they felt that the questions they were asked in the questionnaire were too easy. They felt the questions were fair.

Images were added to the questions as a guide to the expected answer. The results showed that most students saw the relevance of the image. This could therefore be a good exercise to help students integrate the theory they learn during lectures, with the sections they view in the microscope. And to do this in a self-testing environment, can only benefit the students.

This was a completely new way for students to revise the modules, and one had to make sure that the computer itself or the design of the program did not threaten them or cause any confusion leading to poor results. All students could cope with the instructions of the program. No one asked for any assistance.

Self- assessment is perhaps one of the most compelling reasons why computer based learning will most likely succeed. In medicine there is so much to know that most healthcare professionals crave a private non-judgmental mechanism for assessing their own mastery. Books lack the interactivity and public testing can be intimidating. Carefully designed self-assessment computer-based instruction should be well received if it is normative and offers immediate feedback. However one should be quite sure that the test is carefully designed and does not have problems of its own to traumatize students even more. Therefore the questionnaire was so designed to assess this aspect.

GENERAL RESPONSE

The dentistry students have an intense anatomy course for second year. Today's students demand books and other forms of instructions that will be easy to read and yet sufficiently detailed. Because this program was designed not to replace but to support instruction in the pre-existing course, it was thought that students might feel that it is more work added to an already 'full'

course (Whittaker, 1989). However the results of the questionnaire show that the students did not feel that the program was extra work to cover.

Normally in a spot test many of the students encounter problems applying the theory they learn to the sections they view in the microscope. One of the main aims of this project is to provide a facility for them and give them enough practice at this to overcome the problem. From the results it can be seen that all students agreed that these objectives were achieved.

Also there is only one lecturer and one tutor for the 42 students in the dentistry practical class. This causes problems during practical sessions when students are forced to wait long periods until a lecturer or tutor can address their problem (Alper, 1992). If the computers are easily accessible to students during the practical sessions i.e. workstations should be close to the histology laboratories, they will provide students with easy access to relevant information. As a result, students will learn to find the answers themselves. Hence they will need less supervision while doing the practical and only problems of orientation would have to be dealt with by the lecturer or tutor. Most students seem to agree that they would need less assistance and supervision with these programs. Result showed that this is true.

However one needs to add that although this innovative measure lacks the human motivating element of personal interaction, a computerized educational environment must create for the user a surrogate experience sufficiently motivating to hold the users attention. The educational software needs to be continually motivating and attractive.

In there initial stages, the programs have shown to be an effective tool for learning and self-testing of histology. It has both revision and self-testing facilities. The revision allows students access to revision and the self-testing program allows students to interact with an image by allowing them to answer relevant questions concerning the image and chapter they are revising. It is clear from the results that students find this an interesting way to learn histology.

CHAPTER 8

CONCLUSION

Multimedia is being used increasingly to provide computer based learning. One reason for this is that multimedia information helps people to learn. Computer based multimedia instruction may help people to learn more information in less time than traditional classroom lectures. This is especially the case when the multimedia instruction is interactive and learner-paced. (Najjar 1996)

The histology computer based learning program

> "Instructional Technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning." (Oosthuizen, 1995)

In this study the concepts of instructional technology was used in the following ways:

Design and development

Computer based programs in microanatomy of the various systems of the body have been designed and developed 'in-house' by the Anatomy Department of the University of the Western Cape. This was done by joining the expertise of a task team, of a knowledge expert (the lecturer of the subject), a designer (someone with computer skills and a knowledge of Learning Theory and Instructional Design) and a programmer (with educational and computer skills).

Utilization

These computer based programs were installed onto the computers in the computer laboratory of the Anatomy department, which is situated close to the histology practical laboratory, allowing students easy access. Time will be given during the practical sessions to allow students access to the programs.

The programs were also written onto compact discs (CDs) allowing students to borrow them overnight or over weekends, as they do with the textbooks.

Management

Rosters were drawn up allowing students to book computers in the computer laboratory for a certain period, if they feel they need another opportunity to revise the programs, on their own or in groups.

A process will also be put into place, which will allow students to borrow the CD's overnight to revise on their own personal computer.

Evaluation

By means of a questionnaire, students were allowed to evaluate the programs and several adjustments have been made to improve the quality of the programs and to make it 'student friendly'. This will be an ongoing process.

The programs have also been shown to lecturers and experts in the field of anatomy and computer science. Verbal opinions were given afterwards, and they were all positive. They felt that:

- The program was easy to follow
- The colourful micrographs made the pages attractive
- Labeled images helped to orientate students
- Text was concise and relevant to the images
- The quiz was an interesting form of assessment

The solid foundation that this program is built on will allow one to expand the program to incorporate other courses and advances in visualisation and other areas of computer and educational technology without abandoning the core program.

The results of the evaluation of this program confirm a high degree of satisfaction with this form of illustration technology.

Working with the courseware enabled students to learn specific factual information and to synthesise and apply knowledge.

Based on experience and the evaluation of this research it is believed that these histological computer based programs are valuable 'educational tools', encouraging independent study and

stimulating further learning. It is also particularly valuable to academically deficient students giving them enough opportunity, guidance and time to master each course.

The challenge of this research has been to introduce these programs into the medical curricula as an educational tool to promote learning of the basic histology course. Medical students, including dentistry students, for whom time is the scarcest commodity were hesitant at first because they perceived it as only a supplement and extra work. However after using the programs and testing their value, they felt that they were definitely a valuable teaching tool to have and that the program should be incorporated into the course.

OTHER ASPECTS OF MULTIMEDIA IN MEDICAL EDUCATION

According to Harriet and colleagues there are potential advantages for using multimedia applications for educational purposes. Some of them are:

- Good multimedia courseware allow students to go at their own pace, giving cognitive flexibility and offers the capacity for personal feedback which not all lecturers can manage in large classes.
- Simulations can provide important supplementary learning arenas for students where laboratories are overcrowded or ill equipped.
- Many educational institutions have embraced multimedia techniques in teaching as a means of reducing the cost of educating students and increasing the effectiveness of the teaching process.
- Multimedia is seen as a way of bridging the educational gap between poorer and better prepared students allowing each to learn at their own pace.

Multimedia courseware and other computer based learning educational tools can offer some of these advantages to enhance conventional teaching methods, but only with attention to planning, development and delivery of computer based materials.

LIMITATIONS OF THE STUDY UNANSWERED QUESTIONS THAT NEED TO BE ADDRESSED.

Although this thesis identified how multimedia seems to help students learn, using one discipline of study, many unanswered questions still remain.

1. Is there an overall theory that one can use to explain these empirical results and to predict results for the future?
2. Since the multimedia programs may affect how learning material is developed, used and retrieved, should procedures be developed to assist with information and retrieval theories.
3. We are now starting to use multimedia as a form of learning various courses, but still use paper and pencil to test students. If we use a different technique to present information, should we not use the same technique to test learning? Multimedia may still be seen to be artificial because the media we use to test students do not match the media we use in our information presentation.

CONCLUSION – MULTIMEDIA INFORMATION AND LEARNING OF THE FUTURE

Information technology is advancing at such a pace that there is a continual flow of innovations offering new and exciting opportunities for medical education.

There is also the internet and now lately we hear more about virtual reality systems that enable users to explore and interact with virtual 3D worlds. Multimedia presents great opportunities to support and enhance medical education. It provides learners with access to information, which can be searched and viewed in a variety of ways.

Multimedia in many instances is not being used to its full potential. It has been suggested in this thesis that some materials developed in microanatomy (histology) are in effect 'electronic text books' which have very few educational benefits over paper-based textbooks. Therefore there has to be a process or procedure put into place where materials can be screened or guide students through the process of selecting good material needed for the course.

Technology is in a position now to offer great potential for teaching and learning medicine. The challenge is to combine the expertise of technologists with the experience of medical educators and basic scientists in their efforts to design and develop innovative approaches towards medical education that will utilize information technology to its full potential for maximum educational value.

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