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CHAPTER 2

LITERATURE SURVEY

The literature was reviewed to explore the research questions asked in this study. Many of the research questions are aimed at our specific type of learner but many other questions deal with issues that are of a more general nature. Questions such as how to develop a multimedia program, what instruments to use, issues surrounding lectures and tests are all questions for which the literature provides answers. Questions that are aimed at our learners are questions such as: “Do our learner’s use the prescribed book, are they satisfied with the lectures, what are our learners’ favourite way of studying and how did they perform in their tests?” Some of the information found in the literature will be compared with the information gathered in the research section of the study.

Since this is a developmental research study, the literature cited is divided into two sections, namely:

- Literature concerning the development of multimedia and E-learning;
- Literature on the issues around learners using multimedia and E-learning.

The matrix describing this chapter is divided into 6 columns. The main topic “The project” is in the first column. The second column contains the four subdivisions of the project, the myths, development, the future of teaching in general and histology in particular and the research. The development is divided into multimedia and the issues around tests. The subdivisions that fall under multimedia are the advantages and disadvantages, the pedagogical considerations, how to deliver, the design issues, elements of the interface and how multimedia and computer-based learning should be implemented. The advantages are divided into the general advantages and the advantages for histology. The pedagogical considerations are divided into general, constructivism, learning objectives and evaluation of multimedia which is further divided into rules of evaluation, evaluation of the users of multimedia and the evaluation of the programs. How to deliver multimedia is divided into three ways in which multimedia can be delivered, video,

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internet and on removable disk. The design issues and elements of the interface are divided into: navigation, buttons and metaphors, changes in state, interface consistency, media integration and biases, coaching the user, progressive disclosure, visual momentum, tool availability, monitors and colour, digital audio, text, things that work, things that should be avoided and design for a web based system. The research is divided into instruments and learner profiles. The two instruments comprise the questionnaire and the records. The questionnaire is divided into issues regarding the traditional course and the issues regarding the use of multimedia. The issues regarding the traditional course embrace to what extent learners use the prescribed book, how learners rate their lectures, how important lectures are and the length of the lectures. The issues regarding the use of multimedia are concerned with the learner's favourite ways of studying, what influences recollection, whether marks improve when using multimedia and whether multimedia should replace the traditional course. An outline of the above follows.

Table 2.1: Layout of Chapter 2

The project	What are the myths surrounding computer-based learning?				
	Development	Multimedia	What are the advantages?	In general	
				For histology	
			What are the disadvantages?	In general	
				Constructivism	
			What are the pedagogical considerations?	Learning objectives	
				Evaluation of multimedia	Rules of evaluation
					Evaluation of users of multimedia
					Evaluation of programs
				How to deliver multimedia?	On video
			On the Internet		
			On a removable disk		
			What are the design issues and elements of the interface?	Navigation	
				Buttons and metaphors	
				Changes in state	
	Interface consistency				
	Media integration and biases				
	Coaching the user				
	Progressive disclosure				
	Visual momentum				
	Tool availability				
	Monitors and colour				
	Digital audio				
	Text – font choosing and reading on screen				
	Things that work				
	Things that should be avoided				
	Design for a web based system				
How should multimedia be implemented?					
What are the issues around tests?					
What lies in the future for teaching in general and histology specifically?					
Research	Instruments	Questionnaire	What are the issues regarding the traditional course?	To what extent do learners use the prescribed book?	
				How do learners rate lectures?	
				How important are lectures?	
			What are the issues regarding the use of multimedia?	What role does the length of a lecture play?	
				What are learners' preferred ways of studying?	
				What influences recollection?	
		Records	Do marks improve when using multimedia?		
Can multimedia replace the traditional course?					
Learner profiles					

2.1 The project

According to Balasubramanyam (S.A., Online) “The computer is the most striking innovation in the field of educational technology after the printing press”.

2.1.1 What are the myths surrounding computer-based learning?

According to the literature, the following myths surround multimedia and computer-based learning.

Computers enhance learning.

Success derived from the use of multimedia is often attributed to the technology used. Research has shown that there is more variance within technology than between technologies like radio, television, film, video and overhead projection. The effectiveness of technology depends more on how the technology is used than the technology itself (Oliver, 1998).

Multimedia and the WWW have become favoured educational technologies because they enable the flexible use of instructional models. They support a variety of learning processes and styles simultaneously. A range of learning enhancing instructional tools can be accessed through multimedia. How these tools are used determine learning outcomes (Oliver, 1998).

Computer-based learning is a superior instructional format.

Many studies have been done to show that computer-based learning (CBL) is a superior instructional format and have proved their point (Oliver, 1998). If however CBL is compared to, not conventional instruction but to other innovative teaching methods like smaller class groupings and cooperative learning, CBL is found to be just as good or slightly less effective. From this one can assume that it is the change in instructional format that brought about the improvement and not the computer (Oliver, 1998).

Multimedia provides an easy way to learn.

Teachers are always looking for ways to make learning easier. However if a medium is perceived as easy, lower mental effort is exerted by the learners which means less learning. To achieve the required outcomes with computer-based learning, programs must be kept challenging and difficult (Oliver, 1998).

Multimedia will replace the need for face to face teaching.

Multimedia can never replace the face-to-face environment completely. At the most it can be a powerful supplement to conventional lecturing. If the multimedia is only a replication of a book on computer little is gained from it. The unique attributes of the technology must be exploited. Even with distance learning, much of the study material is still delivered on paper (Oliver, 1998).

Multimedia is enjoyable and motivating to use.

Well designed materials can be stimulating and challenging, but not all materials are like that. In some cases learners even prefer conventional materials and have avoided using the multimedia. This is the case when the multimedia is repetitive and dull (Oliver, 1998).

Computers are required for every task.

This is called distributed intelligence and is a myth. Even with computer aided instruction (CAI) there is still space for other modes of instruction and ways of acquiring knowledge (Reeves, 1999).

2.1.2 Development

The topics in this section will deal with the development of multimedia as well as issues surrounding tests.

2.1.2.1 Multimedia

The advantages, disadvantages, pedagogical considerations, delivery, design and implementation of multimedia will be looked at under this heading.

2.1.2.1.1 What are the advantages?

The advantages that multimedia have for teaching and learning in general but also for histology more specifically will be covered under this heading.

➤ In General

Multimedia presentations are engaging because they are multimodal, in other words they stimulate more than one sense at a time and in the process may be more attention getting and attention holding (Jonassen and Reeves, 1996). Many educators feel that multimodal access is essential when teaching today's video generation (Perelman, 1992).

Cairncross and Manion (2001) claim that interactive multimedia can create a high quality learning environment that promotes deeper learning but this potential may not be fulfilled in many programs.

McCormack and Jones (1997) state that there is an increase in demand for education resulting in larger class sizes. Higher learner to staff ratios result in a decrease in the interaction between staff and learners. Increased learner numbers may result in lectures being repeated. Higher numbers of learners mean learners with widely different backgrounds, cultures, previous learning experience, preferred learning styles and personal situations. Because of the cost of education, learners expect value for their money. Learners want more feedback, attention and resources. In a traditional situation it is difficult to track a learner's participation and progress. With a web based education system however a learner's participation and performance can be tracked. A web based

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system also allows for learning material to be adapted to suit the special needs of learners.

Kearsley (1990) reported on the results of evaluations done on various interactive multimedia projects and concluded that learners learn material to a deeper level and understand more connections among concepts. There is also evidence that most learners adopt a different type of learning style when using interactive multimedia. A problem solving approach that involves the testing of hypotheses and the building of models about a topic should be adopted.

Multimedia can offer learners:

- Greater access to the subject content (Lesewski and Settle, 1996);
- Increased flexibility in their times and pace of study (Lesewski and Settle, 1996);
- A better understanding of the visual and practical elements of the module (Lesewski and Settle, 1996);
- An appealing and motivating environment (Oliver, 1998);
- Customized individualized instruction to suit the needs of the learner (Oliver, 1998);
- Access to multiple media with increased learner control (Oliver, 1998);
- A colourful and aesthetically pleasing interface to learn from (Oliver, 1998);
- A motivating learning environment (Oliver, 1998);
- Learners learn quicker and learning is more enjoyable. (MacPherson and Brueckner, 2003).

➤ For histology

Harris et al, (2001) mentions that computers provide a very efficient way to learn visual material. At the University of Natal, Mars and McLean (1996) did a study on the perceptions of learners of a computer-aided instructional course in histology. They identified problems through a questionnaire. The main problem was identifying specific structures and cells in histological preparations. These problems were addressed in their program through adequate labelling of difficult cells and structures. Voice/sound files were played explaining images on the computer screen.

The best way to stimulate learning is one on one interaction between teacher and learner or small group interaction (Heidger et al, 2002). Margaret Moga (S.A., Online) states that an important objective of a medical histology course is to train learners to recognize cells and tissue types at the light and microscopic level. However due to space constraints and economics only a limited number of histological images can be shown in histology books, whereas optical disks and websites can be used to make many images available to learners.

In a study by Richards et al (2000) a questionnaire was given to second year medical and dental learners asking them questions about:

- training in microscopy;
- technology and the teaching of histology;
- microscopy in the health sciences workplace;
- the operation of the microscope.

Medical and dental learners were undecided on the issue of a training course in microscopy probably because they feel that the microscope will play a limited role in their careers and was therefore not of great importance to them. They see the microscope as an instrument to be used in specialist postgraduate work. These learners however felt that histology could not be taught without the aid of visual material. To the medical learners alternative forms of histology teaching seemed attractive because they have

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already been exposed to alternative media. Both the medical and dental learners indicated that they would prefer a truly multimedia approach to histology; however they did not feel that the optical microscope should be abandoned.

Meyer (1999) from the University of Western Australia developed a program that is called the “Histology Practical Assistant” to teach learners the practical side of histology. According to Meyer (1999), computers can greatly enhance the effectiveness of teaching and learning histology. A histology course can be completed using a computer program without ever having to use microscope slides or microscopes.

This has a number of advantages (Meyer, 1999):

- Learners can study histological sections outside of normal teaching hours reducing the need for large numbers of microscopes and slide collections;
- Academic staff is no longer needed in practical classes;
- Each learner can be provided with “limited” preparations;
- Self-assessment can be done.
- Teaching costs can be reduced enormously both in salaries and also in resources.

David Begg from the University of Alberta and his colleagues (S.A., Online) are developing a series of modules to teach basic human histology to medical and dental learners which will replace histology laboratory sessions. These computer modules remove the need to learn how to use the microscope to study histology and could reduce the cost of teaching histology significantly. The modules could also be used for distance learning programs.

According to MacPherson and Brueckner (2003), the computer presentations enhanced access to learning material and brought about self paced learning.

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Begg et al (S.A., Online) state that the lessons learned during the development and implementation of their histology modules are of potential interest to other disciplines in the health sciences.

A recent development in the field of histology teaching is the virtual microscope. Lutz Slomianka of the School of Anatomy and Human Biology from the University of Western Australia has made *Blue Histology – The Virtual microscope* - available on the internet (S.A., Online). The website contains descriptions of tissues and cells as well as a simulation of the functions of a microscope. The field of view is however very small and they claim that certain tissues are not well suitable for this type of presentation. According to this website computers are not yet performing well enough to create a virtual microscope for all biological tissues.

This virtual microscope consists of a window that is placed over a larger image and can then be moved around like a slide is moved around on the stage of a microscope. Magnification can be increased from 4X to 10X and 40X. To move the field of view around, coarse or fine steps can be selected.

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Below is an example of the Blue histology virtual microscope.

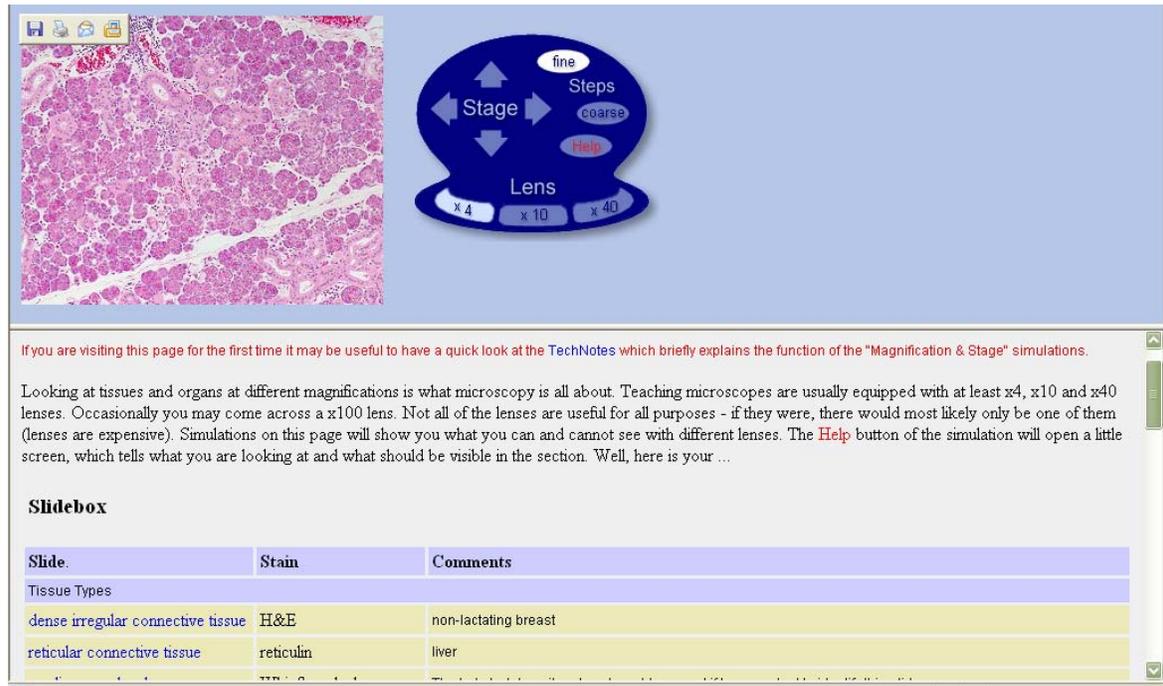


Figure 2.1: First example of the virtual microscope

The Microbrightfield (MBF), Inc. of Williston, Vermont (S.A., Online) developed the virtual slice module which is used to digitise an entire glass microscope slide. The module has a motorized stage which moves the slide around while it is being photographed to obtain a series of contiguous images. These images are then merged into a single seamless montage. The shading error is removed to obtain an image with even illumination. Because the resolution of the individual fields is maintained, the user can zoom in on any section of the slide without loss of resolution. These virtual slides can be made available on an intranet.

If this invention catches on the classroom microscope may share the fate of the slide ruler (Microbrightfield company., S.A., Online). Virtual slice removes the limitation of a microscope not being able to view all of a single tissue section. This feature provides numerous new visualization possibilities (Microbrightfield company., S.A., Online).

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Another improvement on the microscope is the facility to display a macro view of the slide. This can be done in a separate window to show the user what section of the slide he is looking at under high magnification. Thousands of these images can be saved on a server and then streamed to the viewer over the internet. (Microbrightfield company).

Harris et al (2001) of the University of Iowa reported on a study where a virtual microscope was created by using the technology developed by the Microbrightfield company. An area of 1cm² on a histology slide was digitised. Digitising was done at 300 pixels per inch, 24 colour depth and a 40X magnification. Adjacent slides overlapped by 35 pixels so that they could be stitched to form a montage. This resulted in a graphic file which was edited and compressed as a *FlashPix* image of 125megabytes. The Virtual microscope is displayed in a 590X590 pixel html frame on a 800X600 screen on the intranet. Below is an example of such a screen.

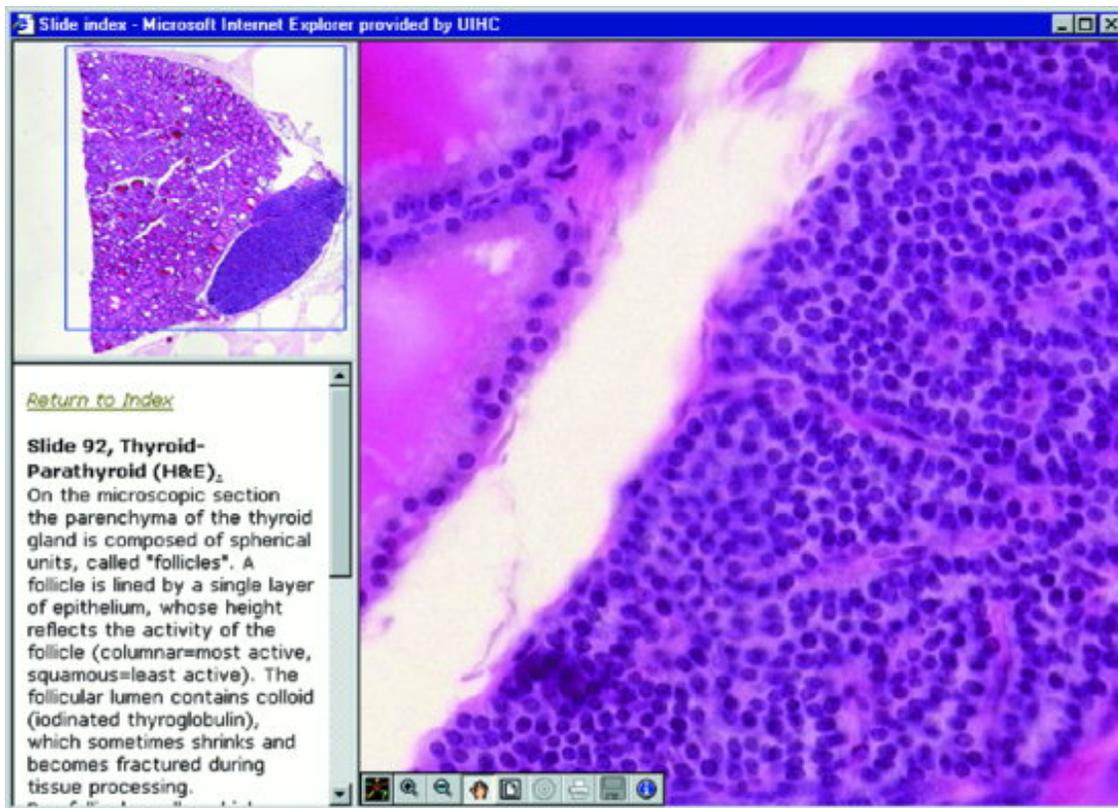


Figure 2.2: Second example of the virtual microscope

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Learners were asked to compare the virtual microscope with the light microscope regarding image quality, affectivity, ease of use, navigation and accessibility.

According to Harris et al (2001) the virtual microscope has the following advantages:

- Lecturers could use the virtual microscope for lecturing;
- Images are just as good as or better than that under the microscope;
- Slides are always in focus;
- The condenser and light adjustment are always ideal;
- The virtual microscope is easier and faster to operate than the light microscope;
- The virtual microscope is accessible on the intranet of the university.

According to the learners that participated in the study the virtual microscope has the following disadvantages (Harris et al, 2001):

- Does not indicate to the learners what they are looking at (there are no arrows indicating structures);
- Does not allow the user to change the focus when viewing thick sections.

In a study that was done by Heidger et al (2002), the Virtual microscope was made available to learners and evaluated by comparing it with the other study material that was at the learners' disposal. Learners were provided with the following study aids:

- Light microscope;
- Virtual microscope;
- Web based histology images (Labeled photomicrographs);
- Video disc atlas and CD Rom (Contain images with labels and text).

Only 8% of learners chose the microscope as their primary study tool, 16% used the virtual microscope as their study aid of preference while the rest (76%) preferred the images on the web, CD Rom and laser disc. The whole group succeeded in passing the

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exam which was conducted with the use of the traditional light microscope Heidger et al (2002).

This study revealed that learners embrace the easiest, fastest method of learning which will give the best results in a test. Learners have little intellectual curiosity and do not care for lasting, concept-grounded learning (Heidger et al, 2002).

2.1.2.1.2 What are the disadvantages?

According to Balasubramanyam (S.A., Online) computer instruction lacks the human and emotional factors of a normal classroom and may not be able to modulate all aspects of the learners' learning. Balasubramanyam also states that learning software in the medical field is currently limited. Development of such programs is time consuming and much more complex than authoring a book on the same topic.

The multimedia that was developed in recent years was done believing that it would increase teaching efficiency and could therefore replace lecturer led teaching (Davies and Crowter, 1996). This would lead to less contact between learners and lecturer which would free the lecturer with more time for research and so increase overall efficiency. Most developers however do not care about effectiveness or existing teaching methods. Materials are used without taking the capabilities and limitations of multimedia into account and therefore they do not exploit the full potential of this way of teaching. When it is claimed that multimedia is more efficient two factors are often forgotten, namely:

- It does not cost much to use multimedia if the facilities exist and the multimedia is already developed but the initial cost to produce the multimedia is often not taken into account;
- When using poorly designed multimedia it can take much longer to reach the required level of understanding than it would be with a lecture (Davies, Crowter, 1996).

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Salomon et al (1991) state that no impact can be expected when technology is only used to make an old activity faster or easier, for this to occur the activity must change. Reeves (1999) points out that when one changes to CAI one cannot keep the message the same, the message must also change.

The most common problem with multimedia is navigation. Multimedia presentations usually contain a mass of information with multiple links between the information. Some programs have many options but fail to give the user an idea of where to start and what route to follow. This has the result of users becoming disorientated, being unaware of how much they have seen and how much they must still do (Jonassen, Reeves 1996). This makes it difficult for learners to integrate the information acquired into their own knowledge structures (Jonassen, Beissner and Yacci, 1993). Learners do not create new knowledge structures when browsing through multimedia (Jonassen and Wang, 1993).

According to Lesewski and Settle (1996), if a learner does not understand a specific section of the course, the chances are that after repeating that section the learner will still not understand it. The computer cannot rephrase an explanation like a lecturer can in a lecture; therefore learners want the lecturer to be available.

Learners see viewing television as something pleasurable and relaxing. Learners view television and video as easy learning environments. However, if learners view a medium as easy they invest less mental effort which means less learning. The same will apply to multimedia on computer. For more effective learning learners must judge a medium as difficult so that they put more mental effort into the learning (Oliver., 1998).

2.1.2.1.3 What are the pedagogical considerations?

When multimedia is developed the developer must keep certain pedagogical considerations in mind. These considerations are discussed here.

➤ In general

According to Reeves (1999), pedagogy is defined as: “The art, science or profession of teaching”. Pedagogical dimensions are concerned with the aspects of design and implementation of CBI that have a direct effect on learning.

Reeves (1999) points out seven pedagogical dimensions that a comprehensive online learning environment should fulfil. These include:

- Task-Oriented: Give learners a task that is to their benefit;
- Constructionist: learners need to produce knowledge representations that show their progress. Learners should receive constructive feedback and opportunity to revise these representations;
- Conversational: Learners should discuss, debate and argue over topics. They must learn how to listen and to reflect and to change their minds. Learning is constructed through online discussions;
- Collaborative: Web based tools for collaboration and group work should be available to prepare learners for team work;
- Challenging: Online learning should not be easy. It should be as difficult as the problems learners will face in the real world;
- Responsive: Online learning communities should respond quickly, accurately and with respect. Supportive networks should form to continue to function throughout a career;
- Reflective: Teachers and learners must learn to engage in thoughtful reflection and metacognition.

Romiszowski (1993) fears that training is moving in a direction, because of technology, which is not pedagogically sound but economically and politically convenient, and would therefore like to see integrated design and development of the product and the supporting environment. Instructional multimedia may be exciting but does not necessarily lead to better educational programs (Romiszowski, 1993). Good instructional design is necessary in any medium.

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Efficient teaching is not always efficient learning. You can teach a dog to whistle but he may not learn to whistle (Davis, 2002). The availability of learning material is no guarantee that learning will take place, learners need guidance as how to use the technologies (Lesewski and Settle, 1996).

Lecturers using multimedia should therefore be more concerned about the learning process (Davies, Crowter, 1996). The emphasis should be on the learning environment and not the medium of delivery (Lesewski and Settle, 1996). The quality of the multimedia is most important. Intellectually stimulating multimedia will motivate learners which in turn will improve their performance. Learners may become overwhelmed by the material and may therefore become lost. When learners do a multimedia course the lecturer's role changes from presenting knowledge to facilitator in the learning process, so multimedia cannot replace the lecturer (Davies, Crowter, 1996). The Multimedia Research Group, University of Natal Durban, (S.A., Online) reports that this change from teacher to facilitator at tertiary institutions may face many obstacles but once the change has occurred, staff will enjoy their new roles and be more involved with the learners.

Learners can approach learning in different ways; some learners may use:

- Surface approach – learning by rote;
- Deep approach – actively searching for meaning (Biggs, 1989; Marton and Saljo, 1984).

To support the learning processes of learners, multiple perspectives in computer facilitated learning should be applied (Eizenberg, Kennedy and Kennedy, 1999). These authors developed a course in anatomy using the systemic and the regional approach as well as adding a third perspective – clinical anatomy, procedures, imaging, dissection and surface anatomy. This approach allows the learners to access information in a way most suitable to their needs while the material also supports higher levels of cognition.

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When Janda (1992) tested a multimedia method of instruction he discovered that learners have learned something but he could not determine what they had learned. From this result he concluded that multimedia advocates must demonstrate the value of this expensive technology by using better methods of research than is currently the case. Simon (1987) suggested that we move away from the idea that knowledge consists of facts and figures to one where knowledge is the ability to retrieve information from data bases and use it to solve problems.

Clark and Craig (1992) reviewed research on multimedia and interactive videodisc and concluded that:

- Multimedia is not the factor that influences learning;
- Gains in learning with multiple media are likely due to instructional methods such as interactivity;
- The aspects of dual coding theory which formed the basis for early multimedia studies have not been supported by subsequent research;
- Future multimedia and interactive videodisc research should focus on the economic benefits (cost and learning time advantages) of new technology.

According to McKenna (1995) many researchers use the term “more effective” in connection with CBL without indicating what is meant by “more effective”. She proposes that effectiveness can be measured in different terms, such as:

- Achievement of learning outcomes;
- Learner satisfaction and motivation;
- Development cost ratios;
- Redeployment of staff;
- Flexibility.

Most research on new technologies used in the learning process reports that there is no significant enhancement (McKenna, 1995).

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According to Flagg (1990), the evaluation of computer-based education (CBE) in its various forms, namely interactive multimedia, integrated learning systems and environments as well as microworlds lags behind the efforts put into development. The consumers of these products assume that because they are advertised as effective they are effective (Reeves, 1999). From Siegel (1994) and Shlechter (1991) it is however clear that the success of CBE is limited.

The Multimedia Research Group, University of Natal Durban, (S.A., Online) is of the opinion that a move away from the didactic mode is necessary to integrate computer technology into course work. Educational problems cannot be solved by computers which are merely another resource like books, experiments or films although more stimulating and much richer. Computers as a teaching tool make learners more responsible for their own learning.

➤ Constructivism

According to Savary (1995), humans explore their environment and from these experiences they construct knowledge. This means that in the multimedia paradigm learners are supplied with an authoring vehicle which they use to learn, and from what they learn they construct knowledge.

To prevent intellectual anarchy when each learner constructs his or her own knowledge Jonassen (1994) suggested a model which includes the following principles:

- Focus on knowledge not reproduction;
- Provide real world case based learning environments;
- Support collaborative construction not competition;
- Promote reflective practice, construction must be context and content dependant.

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According to Piaget's theory as described by Huitt and Hummel (2003), humans cannot understand and use information immediately. They construct knowledge through experience, then build mental models and then change the models through assimilation and accommodation.

Papert (1993) characterizes:

- Behavioural approaches as “clean” teaching – knowledge is broken down to be learned;
- Constructivist approaches as “dirty” teaching – holistic and authentic.

To achieve cognitive constructivism there should be less emphasis on directly teaching skills “clean teaching” and more emphasis on learning in a meaningful context “dirty teaching”. Multimedia offers many such opportunities (Papert, 1993).

According to Cronje (1995), multimedia is ideally suited for constructivist learning because:

- It can adapt to the learning style of each user;
- It can simulate “real life” through multiple options;
- It gives learners the opportunity to learn through doing;
- Incidental learning can take place in the search through hyperspace.

According to the Multimedia Research Group, University of Natal Durban, (online) integration of computer software (both commercial and homegrown) can be successfully integrated into coursework providing the teaching paradigm is changed to the constructivist mode.

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Reeves (1999) mentioned the following myths regarding constructivism:

- Telling (the opposite of constructivism) is always bad. Telling is not always bad it can be appropriate;
- Learners should always work in groups (Social constructivism) – this is not true for there is a time and place for individual work.

➤ Learning objectives

According to Clark (1999, S.A., Online) the learning objectives of a course (Bloom's theory) in ascending order should be:

- Recall and recognize specified information;
- Comprehend and digest the information;
- Apply what they have learned;
- Analyze the subject, with an understanding of the components and their relationships;
- Synthesize the subject, taking an overview;
- Evaluate knowledge, understanding and competence critically.

Multimedia courses focus on the first three learning objectives while some only address the first one. This is called the drill and practice approach (Davies, Crowter, 1996). The last three objectives would be difficult to achieve with the testing that is available on a computer. Therefore, according to Davies and Crowter (1996) multimedia is only suited to courses consisting of a series of concepts.

➤ Evaluation of multimedia

The rules of evaluation and the evaluation of learners and programs are discussed under this topic.

❖ Rules of evaluation

Under evaluation there are two issues (McKenna, 1995), namely:

- Evaluation of the learners after using multimedia;
- Evaluation of the programs.

What are the rules (levels) of evaluation?

Kirkpatrick developed four levels of measure for evaluation of a teaching program (Kirkpatrick, 1959a; 1959b; 1960a; 1960b). Kevin Oakes of Asymetrix Learning Systems sums up the Kirkpatrick levels this way:

Level 1: Smile-sheet evaluation. Did you like the training?

Level 2: Testing. Did you understand the information and score well on the test?

Level 3: Job improvement. Did the training help you do your job better and increase performance?

Level 4: Organizational improvement. Did the company or department increase profits, customer satisfaction, and so forth as a result of the training?

Only the first 2 levels are relevant to this study.

Level 1 - Feelings the learners have about the program (reaction).

Questionnaires at the end of the course can provide the instructor with insight into how the learners feel about the course (perception) and how to increase the popularity of the course (Boyle and Crosby, 1997). Questions such as how much the learners liked the instructor's presentations techniques, how well the topics were covered, how relevant the course contents is for their specific application and how they plan to use their new skills in their job can be asked.

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Learners know what they need to know to accomplish a task. If the training program fails to satisfy their needs it must be determined whether the problem lies with the design or the delivery of the program (Boyle and Crosby, 1997).

Because this level does not give any indication of what skills the learners have acquired or if the course will help them to improve their work, some people do not regard it as very valuable. However this level is important because people learn better when they feel positive about their learning environment (Boyle and Crosby, 1997).

Level 2 - To what extent did the learner learn the required material (learning).

The main question is – did the learner learn anything (Clark, 1995, revised 1996 and 1997)?

According to Clark (1995, revised 1996 and 1997) this level can be defined according to which extent the learner has:

- Changed attitude;
- Increased skills;
- Improved knowledge.

Examinations and quizzes can determine if these improvements have taken place (Clark, 1995, revised 1996 and 1997). Whether the learner has acquired the required knowledge can also be determined (Boyle and Crosby, 1997). Post-testing is only valid when combined with pre-testing to determine what was learned during the training program (Clark, 1995, revised 1996 and 1997). Learning measurements can be used throughout the training program (Clark, 1995, revised 1996 and 1997).

How much a learner likes a course does not necessarily mean that he or she has learned what was intended (Boyle and Crosby, 1997). One must be careful not to

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assume that success on one level will mean success on another level (Boyle and Crosby, 1997).

❖ Evaluation of users of multimedia

The purpose of evaluation is to determine if the materials and the methods used for instruction are accomplishing the objectives (University of Idaho, S.A., Online).

Analysis of evaluation data will expose weaknesses in the instructional process (University of Idaho, S.A., Online). This information can then be used to fix problems and to improve the system (Clark, 1995, revised 1996 and 1997).

Fontana et al (1993) want to see evaluation done that takes account of higher-order thinking skills and that does not measure recollection of facts. They also consider equity issues as being an important impetus from employing traditional evaluation methods to innovative strategies that assess higher-order thinking skills and complex behaviours denoting mastery. In their opinion, research suggests that current uses of information technology in education may be widening the gap between rich and less affluent schools and between high-achieving and at-risk learners.

When control and treatment groups are tested and 'no significant difference' between the two is found it is often based on an end of the course test. According to McKenna (1995), perhaps the test is not testing the right things or the testing is more appropriate for the teaching used with the control group.

❖ Evaluation of programs

Evaluation should be ongoing throughout the whole process of design, development and implementation (Clark, 1995, revised 1996 and 1997).

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According to McKenna (1995), material can be evaluated in terms of its:

- instructional quality;
- level and type of interactivity;
- cost effectiveness;
- ability to meet an identified learning need;
- ability to satisfy learning outcomes.

The evaluation of CBI is, according to Reeves (1999), often presented as statistics on money spent, ratios of learners per computer and time spent on CBI which gives very little information on the effectiveness of CBI. These figures which are easy to collect and to analyze can however be used to convince stakeholders to spend money on CBI (Reeves, 1999).

According to Reeves (1992a), a reason for the lack of evaluation of CBI is the fact that evaluations that have been done previously are not utilized adequately. Evaluation reports are often presented in a format which is almost useless to clients and audiences (Scriven, 1993). Evaluation is often also done too late to have an impact on the design and implementation of CBI (Reeves, 1992a).

When an instructional innovation is compared with another approach through traditional empirical evaluation methods the results of these studies have often been disappointing (Clark, 1992). The reason for this is that these programs often do not differ meaningfully (Cooley and Lohnes, 1976).

One form of CBI can be compared to another form of CBI or two different implementations of the same CBI can be compared through pedagogical dimensions (Reeves, 1999). Although some evaluation theorists deny the use of comparative evaluations (Cronbach, 1980) most clients want these evaluations to be done. Criteria

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for evaluating various forms of CBI should be developed which will result in more valid and useful evaluations (Reeves, 1999).

Eitel et al (S.A., Online) reported that learners suddenly started to reject the in house multimedia programs that were developed and were well accepted by learners earlier. According to Eitel et al (S.A., Online) the reason for this phenomenon was that more and more learners gained access to the internet starting to use web courses with multiple hypermedia links to relevant web sites. These web sites apparently became more popular than the programs that were developed in house.

2.1.2.1.4 How to deliver multimedia

Literature on three of the ways (video, the internet and removable disk) in which multimedia can be delivered are discussed under this heading.

➤ On video

The power of television is widely recognized but the disadvantage of television is the lack of interactivity. The fact that television has a strong visual emphasis and a wide range of possibilities makes television (video) a medium to consider for supporting or even carrying education (Cronje, 1996).

In a study done by Blanc and Martin (1994) video tapes were made of lectures. The advantages of these video tapes are that the learner can control the rate and flow of information, the quality of learner comprehension can be monitored, study skills and content can be integrated and the extended time makes it possible to identify and correct both content and skill deficits. Their aim was to use this new program to address the needs of marginally prepared learners.

Videos that were made specifically for medical learners were very effective, in four years the VSI (Video Supplementary Instruction) was used by 24 medical schools helping

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learners to perform well on medical boards (Blanc and Martin., 1994). This study found that if VSI is used as an alternative instruction at-risk learners can master difficult content and develop requisite skills at the same time. The key to the success of VSI is that the learner can listen to the lecture, stop the video machine and consider the meaning before continuing.

According to Nel et al (1997), video based supplemental instruction can help at risk learners that experience problems with a subject like anatomy. Nel et al (1997) claim that a lecture on a video tape can combine the positive qualities of a lecture with that of small groups discussions. This is done when learners sit and watch a lecture on video under the supervision of a facilitator. When the video is stopped a moment of silence is allowed, this give learners time to form questions, observations and opinions which are then shared with fellow learners (VSI – The center for academic development The University of Missouri-Kansas City). Learner responses on this program include remarks like “When I could not understand the video (lectures) I could listen to my peers to get a clearer understanding” and “It was impossible not to pay attention”.

 On the internet

According to John K Galbraith from eLearn Magazine (S.A., Online), online learning represents the biggest potential change in teaching methods since the inception of formal college education. Some experts believe that the new technology cannot be as good as the one it is replacing. Despite this expert disapproval there is high consumer demand for this user-friendly technology. Universities that refuse to put their courses online will eventually have to do so to survive.

In an experiment that was conducted by Cronje and Clark (S.A., Online) a virtual classroom was constructed. From this experiment it was concluded that this could be a very successful recipe providing certain criteria and rules are adhered to:

- Learners must be computer literate;

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- After exposure to theory and practice learners should be given collaborative projects;
- Course processes and learner progress should be evaluated;
- Learners should be encouraged to post messages;
- Course guides, outlines and information should be provided;
- Design should take research on design, metaphors and navigation into account;
- Communication should take place through classroom E-mail lists and replies should go to all learners;
- Exercises should reflect creativity as well as facilitate trust and rapport;
- Asynchronous learning should be supplemented by synchronous learning (CMC);
- Step by step learning as well as diversity should be catered for;
- Learners should help with the construction of the classroom by making their own websites.

The University of Idaho (S.A., Online), “Distance education at a glance” website points out the following considerations when using the Internet:

- The convenience of internet access may influence the success of the learner;
- Keeping track of learner’s computer problems should become part of the instructional process. Learners may face the following challenges all at once:
 - Learning computer skills,
 - Learning new software,
 - Learning communication skills;
- Learners may be hesitant to communicate through E-mail or at computer conferences because they are not sure of the protocols. Encourage learners early in the course to use the communication facilities. Learners may even be forced to send a minimum number of E-mail messages per week;
- Receiving E-mail from learners makes it possible for instructors to provide quick feedback. Delayed feedback may however make the instructor a facilitator that

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will stimulate learner interaction. Prompt responses to problems will generally increase learner motivation and performance;

- The instructor must be familiar with the resources on the Internet and how to use them most effectively.

will have to increase their instructional design staff and will have to include computer expertise as a criterion for appointing new members of faculty. Faculty members should be encouraged to teach online and should be given exclusive rights to the intellectual property contained in their courses (Galbraith, 2002).

➤ On a removable disk

Electronic documents that are prepared for publishing on a website can also be published on a CD Rom in HTML format (Raymond, 2001). According to Raymond (2001), delivering multimedia material on a CD Rom has the following advantages:

- Lower cost than print especially at high volume;
- Lower shipping costs;
- Very portable and lightweight;
- No Internet access required;
- Content can be viewed on PCs (Windows) and Macintosh if CD is created properly;
- Less expensive than print to publish a new edition;
- As with the Web, CD content can be in multiple formats and provide for flexible access, easy navigation, and print control.

MacPherson and Brueckner (2003), reports on a course in dental histology that was previously presented as 35 mm slides with accompanying text. Learners found this course boring; access was limited because the slides could only be viewed in the library. Learners did not perform adequately with this system. When computers arrived the

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course was digitized and made available on the internet as well as on CD Rom. Learners reported that the CD rom version was far easier because of the image intense nature of the programs and because learners did not always have access to the internet. MacPherson (2003) found that CD Roms facilitate linear access to study materials for personal use.

According to McKenna (1995), many Cd Roms on the market are just data bases of information with no learning strategies built into them.

The virtual microscope contains huge files, 125 megabytes per slide. This would mean that 5 slides would fill a CD Rom. Considering that more than a 100 slides are usually studied in a second year histology course for medical learners it would be impractical to put the virtual microscope on CD Rom. A DVD would be a better way to deliver the virtual microscope (Harris et al, 2001).

2.1.2.1.5 What are the design issues and elements of the interface?

According to Vaughan (1998), a good user interface is essential for a successful multimedia project. Before a program can be designed a set of requirements must be established (Preece et al, 2002). There are two types of design, namely:

- Conceptual design;
- Physical design.

Conceptual design has to do with what the program will do and how it will behave. Physical design has to do with the detail of the design like the appearance of the screen, the menu structures, icons and graphics (Preece et al, 2002). The ideal situation is where a product emerges through designing a prototype (on paper as a storyboard) which is then evaluated and redesigned. The storyboard can either be worked out in great detail and then quickly converted into a finished product or a less detailed

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storyboard can be used which will result in more work at the work station (Vaughan, 1998). The evaluation should be done by users (Preece et al, 2002).

Knowledge and skill in using a computer plays a major part in design (Vaughan, 1998). Talent in using graphic art, video and music is necessary (Vaughan, 1998). The designer must also be able to conceptualize logic pathways through information (Vaughan, 1998). A good interface design will have colours that look good, text fonts that speak and buttons of which the function is easily understood. Jones (1993) stated that screen and interface design should be considered simultaneously when developing a computer-based learning environment. Guidelines for screen and interface design should be flexible to allow for creativity and for the special needs of a project.

The perfect interface should (Fieffer, 1997):

- Give me everything I want
- State information in my terms
- Give information on one click
- Give me nothing I do not want
- Not surprise me.

The interface is the interpreter between user and computer and should provide an easy way for the user to get information without cluttering and without surprises, the program can surprise the user but not the interface (Fieffer, 1997).

User-centered design is a strategy that should be considered when constructing software (Dørup et al, S.A., Online). When this strategy is applied user needs are taken into account. A problem may be that different groups like teachers and learners may not have the same reaction to a program. Vincini (2001) states that experts, as well as representatives of the users of a program must be involved in the design of the program. Prototypes should be tried out and feedback should be given.

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Steyn (2001) did a study to determine the value of learner participation in the design of educational software. It was found that sometimes suggestions that were thought useful by the author were turned down by the learners while the learners sometimes made suggestions that were obviously wrong. The user interface consists of a navigation system and graphic elements. Poor graphics and a disorganized content can be the cause of a failed project (Vaughan, 1998). The type of end user must be taken into consideration. The fact that the end user can be computer literate or illiterate causes a problem. This can be overcome by designing two interfaces – one for novices and one for experts. A modal interface may confuse the user and is best avoided (Vaughan, 1998).

Screen changing should be animated to make sure that the user knows he is looking at a different screen. The user interface should be consistent. The best user interface demands the least learning effort (Vaughan, 1998).

A script was written for each screen for the program that was developed by Mars and McLean (1996). Each image contained detailed information. Clicking on images or words brought up interactions like highlighting of areas on the image, labelling or animation of the image, presentation of additional text, sound or a question related to the topic. Care was taken to make sure that the colour reproduction was faithful. Some images were filtered or enhanced when necessary. Images were sized to occupy a quarter of the screen. Diagrams were also used in the program. Voice files were used to introduce new concepts, give advice on how to use the interactions, ask questions and to supply answers. The voice was in a conversational style to give the impression of an individual tutorial.

A dictionary of new words encountered and references to prescribed textbooks were also provided. A menu offered access to different modules. The modules included self-assessment questions that were asked in the course of the module. Questions varied from MCQs, true/false, text response or drag and drop labelling questions. Spelling errors were allowed but the learner was informed of the error by a voice. Incorrect

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answers produced a verbal explanation as to why the answer was wrong. A mode consisting of a slide quiz was also included. The learner was constantly informed of the number of questions attempted and correctly answered.

A record was kept of each learner's progress. Time spent, module chosen and questions answered correctly was recorded. Learners did this program as an alternative to the usual way of studying that specific section and had to complete a questionnaire after completion of the course. In this study previous computer experience or lack thereof did not play a role in the positive response received by the learners after completion of the course. The use of sound was considered a positive feature.

The following example comes from software developed by Dørup et al (S.A., Online), and shows a sagittal section through the lip. The navigational buttons and the list of links are on the right while some information on the tissue is below the image.

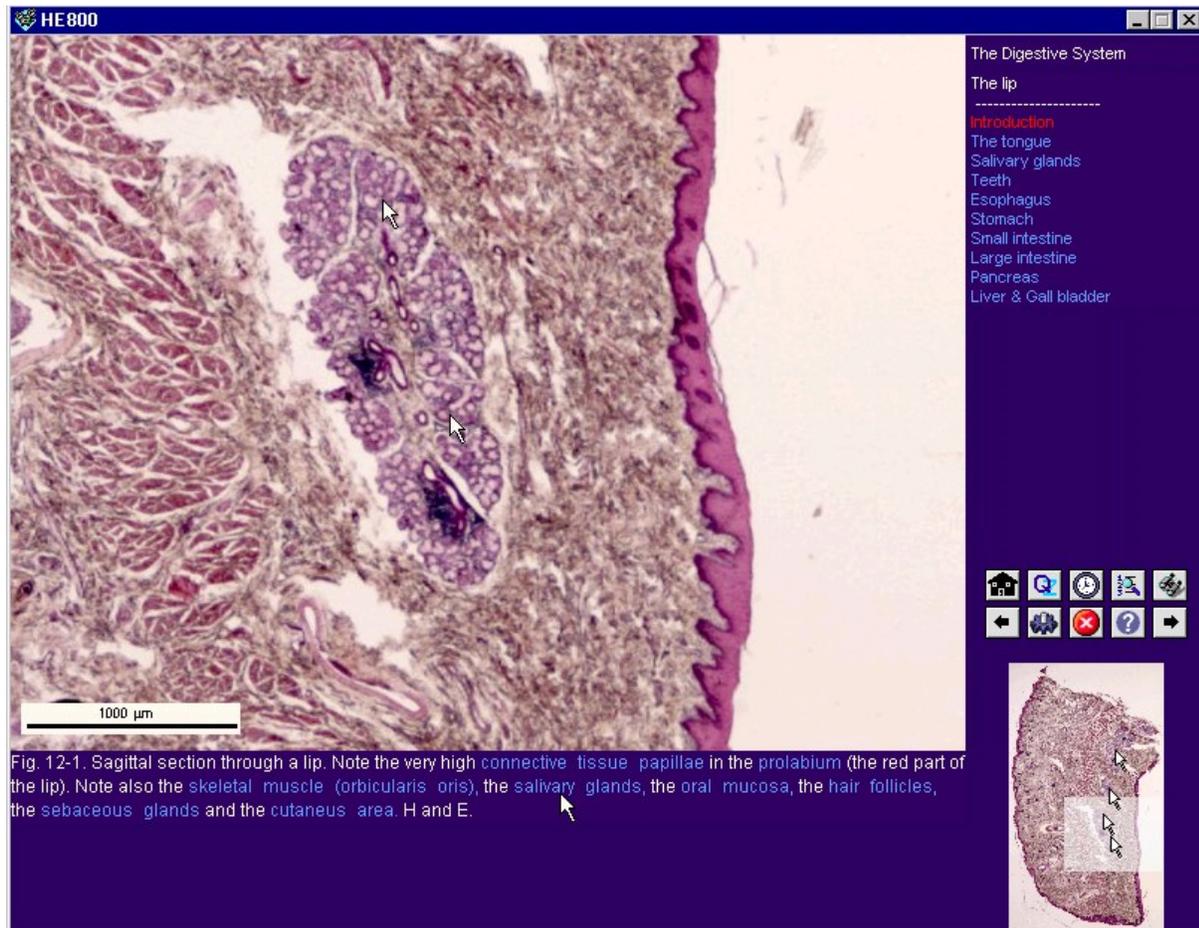


Figure 2.3: First example of the interface of histology multimedia

A course in oral histology developed and reported by MacPherson (2003) has an interface where the screen is divided into three main regions. The left region is for text while the right region of the screen is divided into an upper and a lower part. The upper part contains images and the lower part contains the legend for the images. The images can be enlarged and the user can navigate between pages and also between different modules. The navigational buttons are at the bottom of the screen.

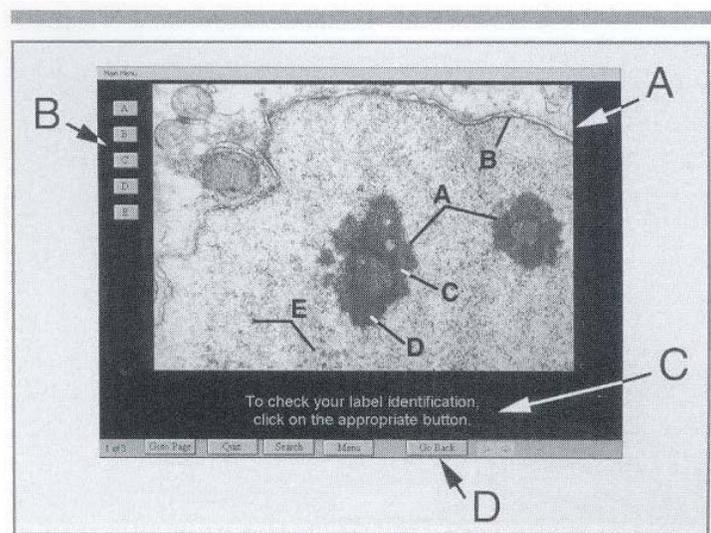
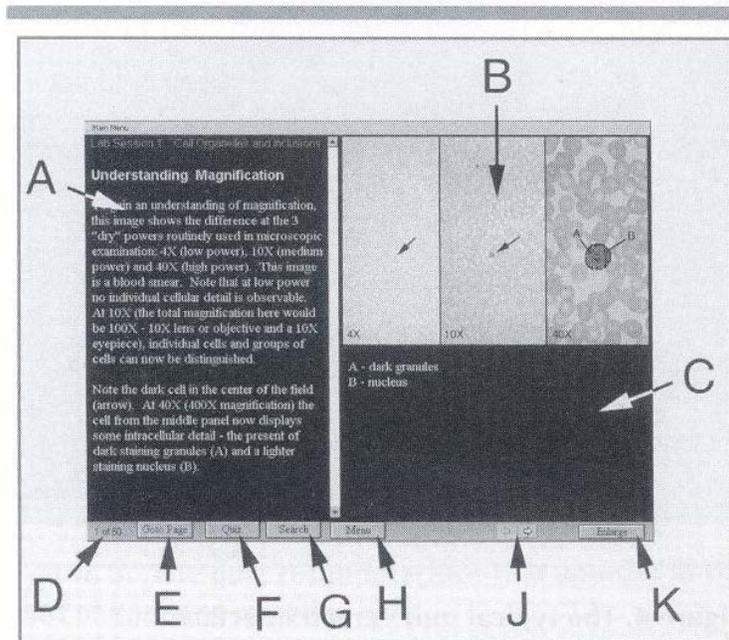


Figure 2.4: Second example of the interface of histology multimedia

➤ Navigation

Navigation is done through menus which supply the user with options (Preece, 2002). Menus can either be:

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- Drop down;
- Pop up;
- Single dialog.

The first two allow for logical grouping of topics (Preece, 2002). Names used in a menu should be unambiguous (Preece, 2002). Vaughan (1998) states that the simplest menu consists of text lists of topics. Text is necessary for the user to keep track of his location.

The following are important points to be kept in mind when designing the program (Laurel, Oren, and Don, 1992):

- A menu with a list of topics should be provided from which the user can then select one by clicking on it;
- Browsing should be flexible but not indiscriminate or uncontrolled;
- A user must know where a topic was found;
- A user must be able to find a topic again.

Navigation can take place in the following ways:

- Linear;
- Non-linear;
- Hierarchical;
- Composite.

In a linear presentation frames follow one another so the information is presented in a sequence which is meaningful to the author, the problem is that unwanted information is also presented so the background of the user is not taken into account (Fiefer, 1997).

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In a non linear presentation navigation takes place freely through the content. In this way of presenting information a response is given to a question when a question is asked during a conversation (Fiefer, 1997).

In hierarchical navigation, navigation takes place along the branches of a tree structure (Vaughan, 1998).

In composite navigation users navigate freely but have to follow some information in the linear way (Vaughan, 1998).

A navigation map should be drawn up early in the project. This will provide a chart of the logical flow of the interactive interface. The navigation chart should be done with the storyboard. The user should always know exactly where he is in the program (Dørup et al, S.A., Online).

A navigation system should take the user to a destination as quickly and with as few actions as possible. The user should not need help (Vaughan, 1998).

Too much freedom can cause users to get lost. To prevent users from getting lost a secure anchor should be given to which the user can return to at any time. If a multimedia project is good, users will get positive feedback within 20 seconds and this will make them to want to go further (Vaughan, 1998).

Most current multimedia is non-interactive and linear. This means that multimedia does not exploit the potential of the technology available (Fiefer,1997).

Lisewski and Settle (1996) designed and developed a multimedia course in weed biology. This course consisted of a series of concepts and it was therefore decided that the best delivery format for a course like this was linear. Any information could however be accessed through an index page.

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A program must have tools like a search engine or an index or both to search the information in a program (Laurel, Oren and Don, 1992).

➤ Buttons and metaphors

Buttons for navigation can easily be ambiguous and if a good icon does not exist text should be used (Fieffer, 1997). Elements already known to the user should be incorporated (Dørup et al, S.A., Online). According to Steyn (2001), the designer should try and stick to known metaphors like the hand, trashcan and hour-glass. Keywords or special codes should be avoided and provision made for users that make mistakes.

In a study done by Onibere et al (2001), a localized interface using icons from the local culture was tested against an international interface in a multicultural multilingual country. Nakakoyi (1996) showed that culture can affect human computer interaction. Because the effect of colour is small, the study of Onibere et al (2001) concentrated on phrases, jargon and icons. This study found that the preferred way of interaction in Botswana, is with menus rather than with buttons or with hot keys; people understand text-based commands better than icons so there is no need for localized icons.

Using metaphors (books, shelves) for navigation in a program enhances understanding and helps to organize program content. Metaphors should be applicable to the content of the program (Jones and Okey, 1995).

➤ Changes in state

This is where a movement or animation (screen wipes right or left, zoom, dissolving or fading) is used to give the illusion that the program is going forward or backward or that the user is going to a new topic (Nicol, 1990).

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➤ Interface consistency

The way of interaction with different media types should be consistent. Access to all media types should be in the same manner (Jones and Okey, 1995).

➤ Media integration and biases

Vaughan (1998) is of the opinion that users should be able to search and retrieve information from different media types.

According to media biases some types of media are more credible than others. Text is seen as the most credible while other forms of media are less credible. To integrate different forms of media can reduce the bias between different media types.

➤ Coaching the user

Vaughan (1998) states that help, overviews and examples should be provided to make it possible for users to find wanted information.

➤ Progressive disclosure

Information should be made available in small sections. This helps to reduce the complexity of the program. This will also ensure that the user is not overwhelmed by the amount of information (Jones and Okey, 1995).

➤ Visual momentum

According to Vaughan (1998), visual momentum is an important part of a program. The program has to keep the user's interest. Low visual momentum means that a user spends more mental effort on figuring out the program than on learning the content.

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➤ Tool availability

Only the tools that are relevant for a specific screen should be made available. The others should be hidden or greyed out (Vaughan, 1998).

➤ Colour

If a multimedia presentation is going to be displayed on a television monitor the following should be avoided:

- Patterns or mosaic;
- Horizontal lines;
- Extremely bright light or intense colours which will flare up on screen. (Stick to pastels and earth colours);
- Some reds may turn brown on a television screen.

➤ Digital audio

According to Vaughan (1998), sound is the most sensuous element of multimedia. The use of sound can make the difference between an ordinary multimedia project or a spectacular one.

Recordings can be edited using the following software features:

- Trimming (remove blank space);
- Splicing and assembly (removing noises and making longer recordings by adding shorter ones together);
- Volume adjustment, format conversion;
- Resampling or down sampling (change a 16 bit recording into a 8 bit recording);

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- Fade-ins and fade-outs, equalization (modify the frequencies to make it sound brighter), time stretching (change the length without changing the pitch) and digital signal processing (add effects such as reverberation) can be done.

Adding sound to multimedia:

- Decide what kind of sound is needed – fit the sound cues into the storyboard;
- Create or acquire source material;
- Edit sounds to fit the project;
- Test the sound to make sure it is timed properly.

Vaughan's (1998) law of multimedia minimums states that: *"There is an acceptable level of adequacy that will satisfy the audience. This level may not be the best that technology, money or time and effort can buy"*.

Many multimedia developers record sound on tape, choose the best recordings and then digitize them. For high fidelity sound the expensive equipment of a sound studio will be needed. Stereo audio circuits of VCRs can also be used for decent recordings (Vaughan, 1998).

➤ Text – font choosing and reading on screen

The term font is often used when the term type face would be more correct. Text where upper and lower case are mixed read easier than text where only one case is used (Vaughan, 1998).

In print Serif is used because it guides the eye of the reader along the line of text. Sans serif is used for headlines and bold statements. A computer screen is different; when there is a lot of text on the screen it is better to use sans serif. A serif font looks too busy

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and is tiring and difficult to read. A large bold serif looks elegant and gives character to the graphic layout (Vaughan, 1998).

According to Vaughan (1998) text is used in multimedia for:

- Titles – What it is about;
- Menus – Where to go;
- Navigation – How to get there;
- Content – What you see when you get there.

When designing a screen a large portion of text can be put on a screen before it becomes too busy. However if it is a live presentation large fonts and few words with lots of open space should be used. The audience should focus on the speaker and should not sit and try and figure out the writing on the screen. When a great deal of text is presented provide a printing link so that the reader can print and read the document rather than scroll through it on the screen (Vaughan, 1998).

How to choose a font for a multimedia presentation (Vaughan, 1998):

- For small type use the most legible font – decorative fonts are useless;
- Different fonts should not be used on the same screen – rather use italics, bold styles and different sizes to vary the weight;
- Adjust the leading for the most pleasant line spacing (not too close);
- Vary the size of the font according to the importance of the message;
- When you have a headline written with large letters, adjust the spacing between the letters so that it feels right;
- Experiment with different colour text on different backgrounds to make your text more legible;
- Use anti-aliased text for titles and backgrounds. (edges are dithered);

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- When using centered type keep the lines to a minimum;
- To grab attention graphically alter and or distort text;
- Experiment with shadowed text. (Copy a different colour on the original text and offset it);
- Surround headlines with plenty of space;
- For text links on web pages use colours consistently and avoid iridescent green, red, purple or puce;
- Emphasize text to highlight ideas. Make sure that it does not look like a button when it is not;
- On a web page put the important text elements or menu items in the top 320 pixels because only 10 to 15% of people scroll a page.

Reading on a computer screen is slower and more difficult than reading the same text in a book. People blink 3-5 times / minute when reading on a screen but 20-25 times / minute when reading text on paper. Monitors should be lower than eye level. Only a few paragraphs of text should be presented and the whole paragraph should preferably be on the same screen (Vaughan, 1998).

➤ Things that work

Vaughan (1998), suggests the following graphical approaches to be incorporated into the interface:

- Contrasts – like thick and thin text, big and small or bright and dark images or text;
- Simple clean screens with open white spaces (non information areas);
- Things that catch the eye like a single bright coloured object alone on a grey screen;
- Objects with shadows;

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- Important text or images emphasized by reversed graphics;
- Text in 2D and 3D.

➤ Things that should be avoided

According to Vaughan (1998), a graphic designer should stay clear of using the following graphical approaches when designing the interface:

- Colours that clash, most graphic artists know intuitively when colours are not matching;
- A cluttered screen with too much information;
- Funny sounds when a button is clicked;
- Requiring more than two button clicks to quit;
- Too many elements presented too quickly.

➤ Design for a web based system

According to McCormack and Jones (1997), the first step when planning a web-based education system is to identify goals. One should decide how one wants to achieve these goals and then prioritize one's list.

Goals may include:

- Provide the learner with early and regular opportunities for self testing;
- Identify learners having problems;
- Increase interaction.

McCormack and Jones (1997), suggest that the Web should not be used for everything. The Web will not always be the most appropriate, effective or efficient solution to a particular problem. A mixture of traditional (e.g. print based distance education) and Web

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based approaches should be used. This will provide a backup in case the technology fails.

McCormack and Jones (1997) also suggest the following:

- Multiple approaches should be used to cater for different learning styles and abilities;
- Keep your Web based classroom simple;
- Find out what others are doing to avoid their mistakes;
- Do not restrict yourself to existing methods; great benefits are possible with a new approach.

McCormack and Jones (1997) suggest the following guidelines to design a web based education system:

- Include no more than five elements per page. Most people's short term memory cannot hold more than five pieces of information;
- Concentrate on the content. The design of the interface should not distract attention from the content;
- A good design is a simple one;
- Make sure your pages are easy to read and to understand;
- Visitors to your pages must know where they are in relation to the rest of the pages;
- Be consistent. When you are consistent visitors can predict how to perform tasks;
- Be accurate;
- Be unique;
- Appearance must match the purpose of the page.

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At present multimedia presentations are a novelty, so learners may look forward to using it and may have a higher attention span. Designers will have to think about how to maintain this attention (McKenna, 1995).

Schroeder (1992) warns that some programs concentrate on breadth rather than depth of learning. A learning program should not be a click and see (Litchfield, 1993) program with 'surface-level interactivity' (Romiszowski, 1993) where learners have control to browse (jump around and get confused) through lots of information and become lost, and do not know what is important and what is not (Cates, 1992; Schroeder, 1992) or learners can form inaccurate mental models by making the wrong connections (Cronje, 1995). The learner must be given goals and the educational package should help the learner maintain a sense of mission and the instructional process must be planned.

Care must be taken not to give learners too much freedom and too little guidance because they might get lost in hyperspace or make the wrong mental models (Cronje, 1995).

2.1.2.1.6 How should multimedia be implemented?

The following issues concerning the implementation of an online forum which are also valid for the implementation of multimedia computer presentations are mentioned by McCormack and Jones (1997):

- Requirement fulfillment: Before multimedia computer presentations can be implemented the technical and nontechnical requirements must be in place. The technical requirements are the hardware and software and the nontechnical requirements are the support procedures.
- Training: Some training should be supplied to inform users how to utilize the multimedia computer presentations.
- Alternatives: An alternative system that does not rely on technology should be in place in case the technology fails.

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- Access: The users should have access to the multimedia computer presentations.
- Testing: The software must be tested under the same conditions and with the same hardware that the users will have access to.
- Starting: A face to face meeting with the users telling them what to expect before they start using the software will be very useful.

2.1.2.2 What are the issues around tests?

An important aspect of testing is reproducibility which means that the same mark should be obtained with two tests on the same work by the same learner (Norcini, 2002). The following table from Norcini (2002) gives the reproducibility of assessment formats studied by the American Board of Internal Medicine (estimates, based on three hours' testing time, will vary in other settings depending on quality of test material and heterogeneity of examinees). The higher the reproducibility coefficient, the better the reproducibility rate of the type of exam.

Table 2.2: Reproducibility of different types of exams

Format	No of cases or items	Reproducibility coefficient
Oral examination (long cases)	2	0.39
Computer simulation (long cases)*	3	0.55
Written simulation (long cases)*	6	0.70
Miniclinical evaluation exercise (short cases)†	9	0.73
Multiple choice questions: single best answer*	90	0.88

*Based on data found in studies by Norcini et al (1995).

†Based on data found in studies by Norcini et al (1986).

From this table it is clear that multiple choice questions have a very high reproducibility coefficient.

The following example of a histology practical test was found in the literature (Ogilvi, S.A., Online):

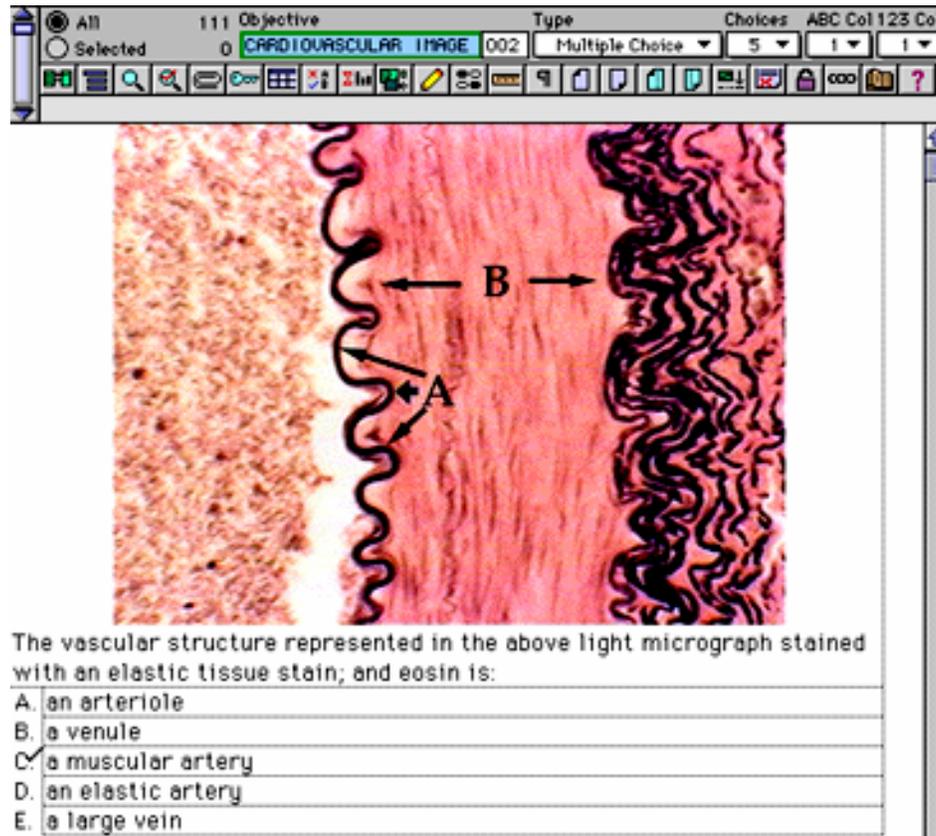


Figure 2.5: Example of the interface of a histology test

2.1.3 What lies in the future for teaching in general and histology specifically?

According to Monnard (S.A., Online), there is no agreement regarding the best way to use technology in the future or the future structure of educational institutions. The course website containing all the learning material will play a key role in the future of teaching. Teachers and learners together will form a virtual classroom. Online communication in the form of discussion areas and or help areas will provide a sense of community which will increase the amount of interaction between learners and lecturers and create an

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intellectual bond between them which is not always possible in the traditional classroom (especially in large classes) (Monnard, S.A, Online).

There will in future be less traditional lectures (Monnard, S.A., Online), and the role of the lecturer will change to that of a mentor that encourages, stimulates and guides much like the old apprenticeship system (Boettcher, 1996). Study material will be in the form of simulations, audio, video and electronic mail (Monnard, S.A., Online). Learning will be constructive, goal orientated, systematic and collaborative.

Universities of the future will collaborate more to deliver modules so learners will be able to take online and campus courses from different universities (Monnard, S.A., Online). According to the Yale Bulletin and Calendar (2002-2003) curricula of the future will be designed around small group learning and the use of technology. Hazari (S.A., Online) contemplates that electronic publishing will replace textbooks because updating is easier and availability is instant. According to Harris et al (2001) a comprehensive set of digital replicas of glass slides can replace the slides as well as the microscope. When cable modems and DVDs become commonplace the virtual microscope will be accessible in learners' homes.

2.1.4 Research

The research for this study was done by using two instruments namely a questionnaire and learner records. In order to compile the questionnaire the literature was searched for examples of similar studies. The literature was also searched for studies where learner records were analyzed. The following sections contain descriptions of information that was found in the literature.

2.1.4.1 Instruments

The instruments consisted of a questionnaire and records retrieved from the learners' files. Standards for questionnaires or data capture forms are supplied by the Department of Information Technology Research support.

2.1.4.1.1 Questionnaire

Naicker (1998) developed a tool for evaluating internet or multimedia courseware. This tool suggests that questions should be asked in the following categories: overview, implementation and planning, user interface design, pedagogy and interactivity and curriculum incorporation.

According to the guidelines for creating questionnaires supplied by the Department of Information Technology, the first decision that should be made is about the confidentiality of the questionnaire. If the information gathered from the questionnaire is going to be linked to other information the respondent must fill in some kind of identification on the questionnaire.

Different types of questions are suggested by the Research Support of the Department of Information Technology, such as:

- Sifting questions – if a certain response is given, follow-up questions must be answered;
- Open ended questions – the respondent has to write a comment or explanation and should only be used when absolutely necessary;
- Answer each one - questions: - each question gives options to choose from;
- Choose only one – respondent must choose only one option;
- Choose all relevant – respondent can choose any number of options;
- Ranking questions – respondent must rank options;
- Likert scales – measure intensity of feelings.

➤ What are the issues regarding the traditional course?

Some issues, as described in the literature, regarding the way traditional teaching is conducted are discussed under this heading.

❖ To what extent do learners use the prescribed book?

In a learner evaluation teaching survey done in the United States Air Force it was revealed that the quality and usefulness of course text was rated the lowest of all the criteria in the curriculum. Of the cadets questioned 76% said that they rarely if ever use the textbook. When one chapter from the prescribed textbook was evaluated it was found that only 38% of the content supported the learning objectives. The other 62% of the chapter went into considerable detail or contained material that was not prescribed. The instructors may see this extra information as adding to the overall understanding of the subject matter. When most of the study material is not included into the learning objectives the learners may see the material as unnecessary. The result may be that the learners fail to read the text altogether (Snodgrass, 2000).

A study done by Lawless et al (2001) revealed that when preservice teachers were asked to choose their most favourite way of studying from videotapes, a CD-ROM, hypertext, textbooks, lectures and classroom discussions, their favourite was the video and least favourite was the textbook.

❖ How do learners rate lectures?

The work of a teacher can be evaluated in three ways (Shelvin and Banyard 2001), namely:

- The development and change of a learner;
- Examination results;
- Learners can be asked to rate the lecturer.

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The first type of evaluation is the most difficult and can only be done over a long period and is difficult to quantify. The second and third ways are more measurable. The third way is the quickest and most used method. According to Shelvin and Banyard (2001), the problem with evaluation is whether we measure the most important variable or whether variables become more important because they are easier to measure. Another question is how valid are the measurements from learner evaluations.

According to March and Roche (1997), there is a positive relationship between prior interest in the subject and teaching ratings. There is also a strong positive relationship between leniency in the allocation of marks and ratings of teaching effectiveness (Greenwald and Gillmore, 1997). Fernández et al (1998), showed a weak relationship between class size and learner ratings where large and small classes give the most positive ratings.

If learners have a positive personal and or social view of a lecturer they tend to rate the lecturer more positively irrespective of actual teaching effectiveness (Shelvin and Banyard 2001). The charisma of the teacher also effects the judgement of the learners when rating learner effectiveness (Shelvin and Banyard, 2001).

❖ How important are lectures?

According to Light and Cox (2001), the lecture is almost synonymous with higher education at the undergraduate level. The lecture is seen as an effective way to teach large numbers of learners. The lecture has however also been criticized for not bringing about active learning and interaction between learners (Biggs, 1989). The learning pyramid of The National Training Laboratories (1998, Online) indicates that the retention of knowledge after a lecture is only 5%. The effectiveness of the lecture depends on the structure of the lecture and the relationship with the rest of the course (Biggs, 1989). Lectures are effective in developing low-level cognition like knowledge of terminology

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and facts and comprehension of examples. It is however ineffective in the development of high-level cognition like evaluation, synthesis, analysis and application (Clark, 1999).

❖ What role does the length of a lecture play?

The question – “how long can a learner concentrate during a lecture?” was answered by Loyd (1968) by saying that a learner’s concentration builds up during the first five minutes of a lecture and then starts to decline till just before the end of the lecture when there is slight rise in concentration again.

Johnston and Percival (1976) found that learners do better in questions of which the answers were mentioned earlier during the lecture than questions of which the answers were mentioned later in the lecture.

In a study done by Stuart (1978) on second year medical learners that were highly motivated doing a popular course it was found that learner concentration rises to reach a maximum 10 to 15 minutes after the start of the lecture and then declines till the end of the lecture. This tendency may have been due to the fact that learners reach a point of fact saturation or that learners just get exhausted or bored. Some lecturers could hold the learners’ attention for longer than other lecturers but invariably the learners would lose concentration. It was suggested by Stuart (1978) that a 25-30 minute lecture may be more appropriate than the usual 50 to 60 minute lecture and that the rest of the time could be used for other teaching methods.

➤ What are the issues regarding the use of multimedia?

Various issues on the use of multimedia as found in the literature are discussed under this heading.

❖ What are the learners' preferred ways of studying?

In a study done by Lawless et al (2001) a number of pre-service teachers were asked about their beliefs regarding instructional media. Their response was that to acquire knowledge in general, video discs, CD-rom and hypertext are the most useful while lectures and textbooks are the least useful. They also believe that more visual and auditory stimulation results in a more effective teaching tool.

❖ What influences recollection?

In a study done by Brennan (2001) on medical learners doing a course in psychiatry they found that although the learners felt that attending a lecture led to greater increase in knowledge, the learners that did computer-based teaching could assess, diagnose and manage anxiety better than the ones attending the lecture. According to Begg et al (S.A., Online) who are developing histology modules to replace practical histology laboratory sessions claim that working with interactive study material while studying increases recollection.

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The National Training Laboratories (1998, Online) did some research to determine the average retention rates for the various ways of learning and drew up the following pyramid:

Average learning retention rates

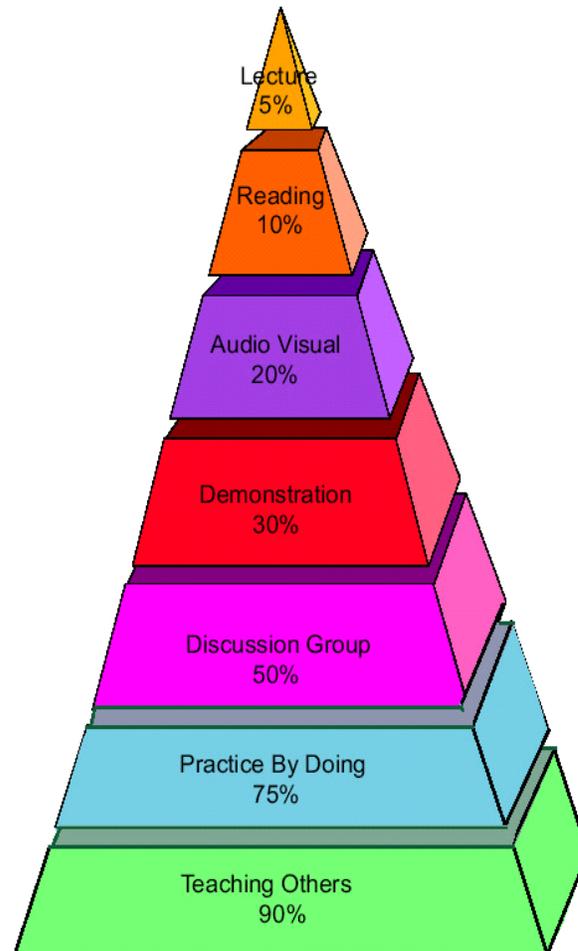


Figure 2.6: Average learning retention rates pyramid

According to the National Training Laboratories (1998, Online) lectures score the lowest retention rate of knowledge of all the ways of learning namely 5%. The average retention of knowledge from reading from a book and audio visual presentations are 10% and 20% respectively.

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❖ Do marks improve when using multimedia?

In the study that Lesewski and Settle (1996) did learners were of the opinion that multimedia help to improve their exam marks and that there will be less of a range between best and worst learner as it is a fairer system because it does not give the faster writers and the better note takers an advantage.

According to MacPherson (2003), replacing the laboratory part of the histology course with computer presentations did not improve the marks obtained by the learners during the practical exam but learners claim that they spend less time studying than previously when they used a 35 mm slide and text system.

❖ Can multimedia replace the traditional course?

The Multimedia Research Group, University of Natal Durban, (S.A., Online) reports that learners at the university of Natal adapted easily to the use of computer technology. Learners became productive learners very quickly. Computer technology does not further marginalize disadvantaged learners. All the learners taking part in their study reported that they enjoy using computers.

Reeves (1999) describes the principles that guide the use of computer software programs as cognitive tools in teaching and learning. According to these principles the microscope qualifies as a cognitive tool in teaching and learning because using a microscope for learning provides a constructivist learning environment which allows learners to construct their own knowledge rather than absorbing information given to them. The microscope challenges and stimulates deep reflective thinking that brings about meaningful learning rather than effortlessly instructing the learner like some innovations. For multimedia to replace a cognitive tool (the microscope in the traditional course) it will have to comply with these principles (Reeves, 1999).

2.1.4.1.2 Records

When a comparison is made between records where new technology was used and not used in the learning process there is no significant enhancement (McKenna, 1995).

In a study that Haddon et al (1996) did two groups of learners, one taught in the conventional way and the other with the use of multimedia did not show a significant difference in exam results but there was a significant correlation between learner ability and degree of improvement for the multimedia group. The lower the ability the bigger the improvement. This means that multimedia is more successful than conventional methods for learners of below average ability.

2.1.4.2 Learner profiles

According to the Multimedia Research Group of the University of Natal Durban (S.A., Online) their university has selection criteria other than school performance as a prerequisite for entry into university to allow more disadvantaged learners into university. 80% of their intake now consists of disadvantaged learners.

For most of the learners at the university English is their second language. Most of these learners including those for whom English is a first language have problems with sentence construction and essay writing. This apparently is not only a South African problem; American learners have the same problems.

Many of the learners at the University of Natal (Multimedia Research Group of the University of Natal Durban S.A., Online) come from deprived backgrounds with no three dimensional toys, music lessons and mechanical construction kits, all of which contribute to loss of skills, like dexterity, which are difficult to acquire in adulthood. In biology, dexterity is important in the understanding of anatomy.

The education system that these learners come from is based solely on rote learning. Few learners develop the skills of observation and logical thinking. Because of these

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problems learners have difficulties in solving problems. This is demonstrated by the small number of black science and engineering graduates.

The Multimedia Research Group, University of Natal Durban (S.A., Online) states that the learners they are dealing with do not want to learn; they want to be taught. They only want to memorize information and learn how to answer exam papers. Most accept what they are taught blindly.

The following terms are used by people that use computers in teaching and learning. Terms have not yet been standardized. Some of the terms mean exactly the same.

- Computer based learning: Learning where the computer contains the main resource for learning.
- Computer based education: Refers to a system where a learner is educated by a computer. The computer is used for the whole process including tracking and keeping records.
- Computer based instruction: The computer gives the instruction, this instruction can be from a resource on the computer or it can be on the internet or both.
- Online learning: Learning material is on the internet.
- Web based education: The resource is on the internet
- Telematic material: Material that is delivered over a distance.
- Multimedia: Information that is delivered in a format that combines more than one of the following: text, graphics, still images, animation, audio and video.
- Multimedia resource: Study material that is presented in the form of multimedia.
- E-learning: A term that encompasses all forms of electronic application for learning namely web based learning, computer based learning, virtual classrooms and digital collaboration. The content for E-learning is delivered using

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any or more than one of the following: Internet, audio or video tape, radio, television and CD-Rom.

- Course work: A term that refers to all the work that has to be done for a specific course.
- Educational package: A term that includes all the ways of learning including books, lectures and computer presentations.