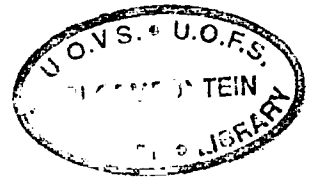


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**COMPUTER-ASSISTED LEARNING:
A WEB-BASED APPLICATION IN HISTOLOGY**

by

ALWYN PIETER HUGO

Script submitted in partial fulfilment of the demands for the Module
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(consisting of seven modules, a research project and a script)

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AT THE UNIVERSITY OF THE FREE STATE**

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FORTH RIVER

Dedication

To all the **geeks** and **gurus** who discuss their web development problems and solutions in discussion forums on the Web. The Web is a place of learning because of you. I **salute you**.

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Dr Hennie Geyer

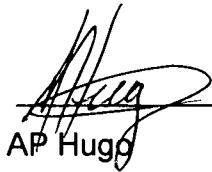
The multi-tier web-based application's development and functionality is for the most part directly linked to your ability to be critical of instructional tools, gimmicks and content. I am most grateful that the application meets your approval. Thank you for your advice and participation in the project.

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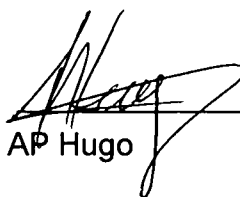
Declaration

I hereby declare that the work submitted here is the result of my own independent investigation. Where help was sought, it was acknowledged. I further declare that this work is submitted for the first time at this University/Faculty towards an M.PHE degree in Health Profession Education and that it has never been submitted to any other University/Faculty for the purpose of obtaining a degree.


AP Hugo

15/03/2004
Date

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TABLE OF CONTENTS

	Page
CHAPTER 1	
ORIENTATION AND BACKGROUND	
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT	3
1.3 AIM	4
1.4 OBJECTIVES	5
1.5 METHODS AND OUTPUTS	6
1.5.1 Primary interface	7
1.5.2 Primary object	7
1.5.3 Secondary object	7
1.5.4 Secondary interface	8
1.6 SCOPE OF STUDY	8
1.7 STUDY DESIGN	9
1.8 SIGNIFICANCE AND VALUE OF THE STUDY	10
1.9 DEFINING TERMINOLOGY	11
1.9.1 ActiveX Data Objects (ADO)	11
1.9.2 Active Server Pages (ASP)	11
1.9.3 Client-sided commands	11
1.9.4 Computer-assisted learning (CAL)	12
1.9.5 Hypertext Markup Language (HTML)	12
1.9.6 JavaScript and Vbscript	13
1.9.7 Multi-tier	13
1.9.8 Open Database Connectivity (ODBC)	14
1.9.9 Server- sided commands	14

1.9.10	Structured Query Language (SQL)	15
1.10	ARRANGEMENT OF THE REPORT	15
1.11	CONCLUSION	17

CHAPTER 2

TRENDS IN COMPUTER-ASSISTED LEARNING (CAL)

2.1	INTRODUCTION	18
2.2	BACKGROUND	19
2.3	TRENDS IN COMPUTER-ASSISTED LEARNING	20
2.3.1	Delivery environment	20
2.3.2	Pedagogy	22
2.3.2.1	<i>Endogenous constructivism</i>	23
2.3.2.2	<i>Exogenous constructivism</i>	24
2.3.2.3	<i>Dialectical constructivism</i>	24
2.3.3	Instructional design	25
2.4	SUMMARY	27

CHAPTER 3

METHODS

3.1	INTRODUCTION	28
3.2	STUDY DESIGN AND METHODS	29
3.2.1	Study design	29
3.2.2	Methods	30
3.2.3	Study population and study sample	31
3.3	DATA COLLECTION	31
3.3.1	Questionnaire 1: Computer competency	33

3.3.2	Observation Checklist: Content management	33
3.3.3	Questionnaire 2: Evaluation by lecturers	34
3.4	PILOT STUDY	34
3.5	ETHICS	35
3.6	DATA ANALYSIS	35
3.7	SUMMARY	36

CHAPTER 4

BUILDING THE TIERS

4.1	INTRODUCTION	37
4.2	THE FOUR TIERS	39
4.2.1	Primary interface	39
4.2.2	Primary object	40
4.2.3	Secondary object	41
4.2.4	Secondary interface	42
4.3	SUMMARY	43

CHAPTER 5

UNIFYING THE TIERS

5.1	INTRODUCTION	44
5.2	CONTENT MANAGEMENT	45
5.2.1	Navigation of lecture topics – primary interface	46
5.2.2	Content modification – primary interface	47
5.2.2.1	<i>Edit-function</i>	48
5.2.2.2	<i>Delete-function</i>	50
5.2.2.3	<i>Add-function</i>	50

5.2.3	Selecting content	52
5.3	CONTENT PRESENTATION	54
5.3.1	Navigation of lecture topics – secondary interface	54
5.3.2	The slide shows	54
5.3.2.1	<i>Content components</i>	55
5.3.2.2	<i>Navigation components</i>	56
5.4	SUMMARY	56

CHAPTER 6

RESULTS

6.1	INTRODUCTION	57
6.2	QUESTIONNAIRE 1: COMPUTER COMPETENCY	57
6.3	OBSERVATION CHECKLIST: CONTENT MANAGEMENT	60
6.4	QUESTIONNAIRE 2: EVALUATION BY LECTURERS	61
6.5	SUMMARY	64

CHAPTER 7

DISCUSSION AND RECOMMENDATIONS

7.1	INTRODUCTION	65
7.2	EDUCATIONAL CONTEX OF APPLICATION	65
7.2.1	General	65
7.2.2	Primary interface	68
7.2.3	Secondary interface	68
7.3	PEDAGOGY	69
7.3.1	M.B.Ch.B programme at UFS	69

7.3.2	JavaScript slide show in MEE 113	69
7.3.3	<i>Instructivisim and behaviourism</i>	69
7.3.3.1	<i>Constructivisim</i>	70
7.4	DESIGN CONSIDERATION	71
7.4.1	Primary interface	71
7.4.1.1	<i>Navigation</i>	71
7.4.1.2	<i>Column-row format</i>	72
7.4.2	Secondary interface	73
7.4.2.1	<i>Navigation of lecture topics</i>	73
7.4.2.2	<i>Navigation in slide show</i>	74
7.4.2.3	<i>Identification-button</i>	74
7.4.2.4	<i>Text boxes</i>	74
7.4.2.5	<i>Display – 800x600 dpi</i>	75
7.5	EVALUATION DISCUSSION	76
7.5.1	Questionnaire 1: Computer competency	76
7.5.1.1	<i>Basic skills in MS Windows and MS Office</i>	76
7.5.1.2	<i>Internet and e-mail use</i>	77
7.5.1.3	<i>Programming and web development</i>	77
7.5.1.4	<i>Summary: Questionnaire 1</i>	78
7.5.2	Observation Checklist: Content management	78
7.5.2.1	<i>Navigation of content menu</i>	79
7.5.2.2	<i>Modification; edit, add, delete</i>	79
7.5.2.3	<i>Selection</i>	79
7.5.2.4	<i>Summary: Observation Checklist</i>	80
7.5.3	Questionnaire 2: Evaluation by lecturers	80
7.5.3.1	<i>Understanding the different tiers and functions</i>	81
7.5.3.2	<i>Display issues</i>	81
7.5.3.3	<i>Perceived value</i>	82
7.5.3.4	<i>Summary: Questionnaire 2</i>	83

7.6	FUTURE DEVELOPMENT	83
7.6.1	Action research recommendations	84
7.6.2	Open source environments	84
7.6.3	Secondary object	85
7.6.4	On-line help	86
7.7	SUMMARY	86
7.8	CONCLUSION	86

REFERENCES	88
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APPENDIX A

QUESTIONNAIRE COVER PAGE	i
LETTER TO PARTICIPANTS	ii
QUESTIONNAIRE 1: COMPUTER COMPETENCY	iii
QUESTIONNAIRE 2: EVALUATION BY LECTURERS	vi
OBSERVATION CHECKLIST: CONTENT MANAGEMENT	ix

APPENDIX B

USER MANUAL

1.1	INTRODUCTION	i
1.2	CONTENT MANAGEMENT	ii
1.2.1	Navigation	ii
1.2.1.1	<i>Navigation to application</i>	ii

1.2.1.2 <i>Navigation in application</i>	iii
1.2.2 Content storage – primary object	iii
1.2.3 Content management interface	iii
1.2.3.1 <i>Editing</i>	iv
1.2.3.2 <i>Addition</i>	v
1.2.3.3 <i>Deletion</i>	vi
1.2.3.4 <i>Selection</i>	vi
1.3 CONTENT DISPLAY	viii
1.3.1 Content storage – secondary object	viii
1.3.2 JavaScript slide show	ix
1.3.2.1 <i>Navigation in slide show</i>	ix
1.4 ON-LINE HELP	x

LIST OF FIGURES

	Page
Figure 4.1: Graphical display of multi-tier web-based application	38
Figure 5.1: Content menu page	46
Figure 5.2: Modification page - primary interface	48
Figure 5.3: Editing page - primary interface	49
Figure 5.4: Addition page - primary interface	51
Figure 5.5: Selection page - primary interface	52
Figure 5.6: JavaScript arrays – secondary object	53
Figure 5.7: Slide show – secondary interface	55

LIST OF ACRONYMS

ADO	-	ActiveX Data Objects
API	-	Application Programming Interface
ASP	-	Active Server Pages
B.Med.Sc.	-	Bachelor of Medical Sciences
CAL	-	Computer-assisted Learning
Dpi	-	Dots per inch
E-mail	-	Electronic mail
FTP	-	File Transfer Protocol
HTML	-	Hypertext Markup Language
IIS	-	Internet Information Server
M.B.Ch.B.	-	Bachelor of Medicine, Bachelor of Surgery
MEE 113	-	Tissues of the Body module in M.B.Ch.B. programme
ODBC	-	Open Database Connectivity
PHP	-	Personal Home Page Hypertext Pre-processor
SGML	-	Standardised General Markup Language
SQL	-	Structured Query Language
UFS	-	University of the Free State
URL	-	Universal resource locator (Web page address)
WWW	-	World Wide Web
WYSIWYG	-	What you see is what you get

COMPUTER-ASSISTED LEARNING: A WEB-BASED APPLICATION IN HISTOLOGY

CHAPTER 1

ORIENTATION AND BACKGROUND

1.1 BACKGROUND

Computer-assisted learning (CAL) enjoys much support in the educational field today, especially in learner-centered programmes and problem-based programmes. Literature suggests two important reasons to use CAL in courseware. The first is due to the flexibility of CAL material or courseware, as learners are not restricted to access the material at a particular time or place, and second, the learners have control of their own learning (Carr-Chellman & Duchastel, 2000:232).

Currently the development of CAL programmes tends to be towards delivery in a web environment (Rushby, 2000a:183), the most important reasons being the capabilities that a web environment has in data collection, interactivity and presentation (Senese, Bender & Kile, 2000:s.p.), as well as connectivity and data sharing across different platforms and centres (Jones, 2000:4).

A more important trend in the development of CAL material is the tendency to base the development on sound educational and pedagogical principles (learning strategies) as opposed to simply bombarding learners with content in a web environment (Carr-Chellman & Duchastel, 2000:240). Hinostroza and Mellar (2001:27) showed the importance of integrating teaching styles/methods into CAL material, instead of just concentrating on learning strategies. This trend encourages the development of dedicated applications concerning specific content (Senese et al., 2000:s.p).

With this in mind, a web-based JavaScript slide show engine was developed as a computer-assisted learning application (CAL application) for use in the Module MEE 113 of the new M.B.Ch.B. programme in the School of Medicine, University of the Free State (UFS). This module deals with tissues of the body and focus is placed on histology as content. The slide show was developed to give learners the opportunity to extend contact time with learning material in a structured way, but without the time constraints of normal classes. Images with descriptive text form the basis of the slide show engine; the learner can move through images (forward and backward) in the slide show with interactive buttons. The descriptive text is not presented initially on rotation, but the learner must request it by pressing an interactive button. The content of the slide show (image reference and descriptive text) is stored in JavaScript arrays.

The rationale of the slide show builds on a teaching strategy of the lecturers in the module. Learners used to schedule a time with the lecturers to review sets of 35mm slides of histology images. The lecturers helped learners revising the work by identifying the tissue and specific structures according to specific characteristic features. The UFS has a parallel medium teaching policy and the lecturers had to present each set at least twice (once in Afrikaans and once in English). If learners could not attend one of the revision sessions, time was always found to schedule an extra session. The JavaScript slide show was developed to replace this practice with a more flexible method to enable the learners to access the content in their own time and at their own rate.

At first it was envisaged that the lecturers would be in charge of the content after it had been placed in the arrays, but editing the arrays proved time-consuming and beyond the computer skills of the lecturers.

The study was aimed at the development of a web-based application to enhance the instruction of histology content. The main focus was the development of an interface through which the lecturers could manage the content in the JavaScript arrays and thus ultimately in the slide show.

1.2 PROBLEM STATEMENT

Learners interact quite successfully with the web-based JavaScript slide show described above. From time to time learners will report an

ambiguous statement in the descriptive text to the lecturers. The process to rectify this takes time and involves the developer, since editing the JavaScript arrays is time-consuming and needs a certain level of programming skill to accomplish. Learners believe that the developer is in charge of content and they mistrust the content.

The problem which was identified entails the following: The lecturers needs to be in charge of the content; s/he needs to be able to edit the text and to change the images in the slide show. Content management by the lecturers will act as a quality assurance measure and learners will have more faith in the content of the slide shows. The lecturers must be able to upgrade or modify the content, i.e. change images for better ones or change the descriptive text. This will lead to better utilisation of the slide show engine and the lecturers will ultimately be able to use it as a primary instruction tool.

To accomplish this, management of content in the slide shows must be simplified; in other words, the editing of the JavaScript arrays has to be simplified. The suggested web-based application in histology must simplify content management in the JavaScript slide shows.

1.3 AIM

The aim of the study was to establish a permanent solution to the problem of content management in the JavaScript slide shows. The solution had to

place the lecturers in charge of content management. It had to be accomplished without the lecturers acquiring any programming skills.

The suggested solution was to develop a multi-tier web-based application with two distinct interfaces; one to manage histology content (primary interface), and one to present histology content to learners (secondary interface). The application would be utilised by the lecturers and learners of the module MEE 113 (Tissues of the body) in the undergraduate medical programme, School of Medicine in the Faculty of Health Sciences of the University of the Free State, South Africa.

The secondary interface incorporates the JavaScript slide show engine, since it is well established and will save time on development of a new presentation interface. In the primary interface, editing of the JavaScript arrays by the lecturers must be accomplished in a simple and quick way. This was the primary problem and the main focus of the study.

1.4 OBJECTIVES

The following objectives were pursued to realise the aim of the study:

- A selective literature study relating to the field of CAL was conducted to serve as background to the study.
- Available programming techniques applicable to the web environment were studied to find the most suitable techniques.

- The described multi-tier web-based application was developed.
- The multi-tier web-based application was implemented.
- The multi-tier web-based application was evaluated.

1.5 METHODS AND OUTPUTS

The focus of the study was on the editing of the JavaScript arrays in the slide show. A method to present the content in the JavaScript arrays to the lecturers for easy editing and to automate the building of new JavaScript arrays once the editing was completed, had to be established. This would facilitate content management of the JavaScript slide shows by the lecturers, since the content in the slide shows is stored in the arrays.

The JavaScript arrays are intricate, but they resemble a database table. It is possible to place the content of the JavaScript arrays in a database. This simplifies the editing of the arrays, since a database interface is quite accessible, even to persons with no programming skills. If the database were to be accessed through a web browser, the developer would be able to utilise programming techniques available for the web environment to automate the building of the JavaScript arrays. If the JavaScript arrays are saved as external JavaScript libraries, it would be possible to programme the secondary interface to reference the JavaScript arrays from the external libraries.

This can only be accomplished if the following outputs are in place to form the specific tiers of the multi-tier web-based application.

1.5.1 Primary interface

In the primary interface the lecturers are able to manage the histology content that is presented to the learners. It was developed as an Active Server Pages (ASP) web page with server-sided scripts to load, display and edit a database, the primary object. This simplifies the editing of the content. Internet Information Server (ISS) needs to be installed on the web server in order to display ASP pages.

1.5.2 Primary object

The primary object, an Open Database Connection (ODBC) database stores all the histology content that may be displayed to the learners. The database is a Microsoft Access database. The primary object resides on the web server and is displayed in the primary interface.

1.5.3 Secondary object

The secondary object acts as data vehicle between the primary object and the secondary interface. It is the JavaScript arrays that contain the edited version of the content, saved as an external JavaScript library file. The process of placing the edited content from the primary object into these

JavaScript arrays and saving it to the external JavaScript library file is automated. This way the secondary interface does not reference the primary object directly, and content in the primary object is much more secure. The secondary object is the crucial element if the JavaScript slide show is to be used as secondary interface for presenting content to the learners.

1.5.4 Secondary interface

The secondary interface presents content to learners. It is a revision of the original client-sided JavaScript slide show that was developed to display histology content to learners. The revision established a link in the slide show to the external JavaScript library file, the secondary object, in order to enable the transfer of the edited content from the primary object to the secondary interface (slide show).

1.6 SCOPE OF STUDY

The study falls within the field of Health Professions Education. The study was undertaken in the School of Medicine at the University of the Free State, South Africa, and was aimed at the MEE 113 module of the M.B.Ch.B. programme that deals with tissues of the body (histology and physiology) on first-year level. The beneficiaries of the study are the lecturers and learners in the module MEE 113.

1.7 STUDY DESIGN

The study design of the study is in the form of action research. According to Landman (1988:51) action research is undertaken by persons who are involved in the development of a solution for a specific problem. Action research specifies that the results need to be implemented to resolve a specific situation (Verma & Beard, 1981:178). In action research the solution of a specific problem/situation does not have to be evaluated against an external standard (Huysamen, 1998:176).

Information was gained through a literature survey on computer-assisted learning and programming techniques applicable to the web environment. The multi-tier web-based application was developed to accomplish the outputs described in **Methods and outputs** (1.5). The application was implemented in the Module MEE 113 in the new M.B.Ch.B. programme of the University of the Free State.

The success of the described solution/application was evaluated in terms of the ability of the lecturers in MEE 113 to manipulate the content in the JavaScript slide shows through the multi-tier web application. The study population was the two lecturers in the MEE 113 module. The constant is the involvement of the lecturers as content experts in the application. Both lecturers participated in the application's evaluation (purposive sampling [Huysamen, 1998:44]). The lecturers were observed while they managed histology content in the application. The observation was

scheduled after the lecturers had become acquainted with the application.

The observation focused on five specific areas in content management:

- Navigation of the content menu
- Editing of descriptive text in the slide show
- Deleting of images and descriptive text from the slide show
- Adding of new images and descriptive text to the slide show
- Selecting of images to be displayed to learners.

1.8 SIGNIFICANCE AND VALUE OF THE STUDY

The aim of the study was to place the lecturers in the module MEE 113 in charge of content management in the JavaScript slide show. The learners in the module MEE 113 will benefit most, since a subject expert will manage the content. The learners will be able to trust the content. When ambiguous statements in the descriptive text are reported, it will be rectified much quicker, since the editing of the text is not done by sorting and searching through the JavaScript arrays, but directly in the database. The multi-tier web-based application is quick and easy to apply to different disciplines, while other institutions may find it useful as well.

1.9 DEFINING TERMINOLOGY

1.9.1 ActiveX Data Objects (ADO)

ActiveX Data Objects or ADO from Microsoft is a high-level interface to provide ease of access to data stored in a wide variety of database sources. The earlier versions of ADO could only access relational databases with fixed columns and data types. However, the newest version of ADO is able to interface not only with relational databases, but also with non-relational databases, folders, data files, and e-mail messages.

1.9.2 Active Server Pages (ASP)

Active Server Pages (ASP) is a secondary web development language from Microsoft. Web pages developed in ASP usually contains server-sided scripts which are executed before the pages are downloaded to a client's computer as Hyper Text Markup Language (HTML) code for display in the client's web browser.

1.9.3 Client-sided commands

Client-sided commands refer to commands that are executed on the client's computer. Typically the commands are scripts (JavaScript and

Vbscripts) that are embedded in the HTML code and the client's web browser parse and executes the scripts on the client's computer.

1.9.4 Computer-assisted learning (CAL)

There are many debates on the use of terms to describe education that is computer-based. The most recent term, e-Learning, may be the most inclusive term to describe computer-based learning or teaching, especially if one takes the definition of e-Learning as given by Charlie Watt, Senior Director of e-Business of Scottish Enterprise. He states in his on-line e-Learning resource application that 'e-Learning is the delivery of learning and training using electronic media, for example, using computers, the Internet and intranet' (2002:s.p.). This definition applied to computer-based instruction, computer-based training and computer-based learning before the term e-Learning was coined (*cf* Rushby 2001:509-510).

In this document the term CAL describes learning material that is computer-based and used by learners to assist them in understanding subject-matter that is primarily dealt with in a classroom.

1.9.5 Hypertext Markup Language (HTML)

Web pages are written in Hypertext Markup Language (HTML) source code. HTML uses tags (for example <h1> Heading </h1>) to structure text into headings, paragraphs, lists and hypertext links. It is a non-

proprietary format based upon Standardised General Markup Language (SGML) and can be created and processed by a wide range of tools, from simple plain text editors to sophisticated What You See Is What You Get (WYSIWYG) authoring tools. Web browsers have interpreters (parsers) that interpret and display the HTML source code.

1.9.6 JavaScript and Vbscript

JavaScript and Vbscript are scripting languages that are used in web development. Scripting languages are embedded into the HTML code of web pages. Scripts are not compiled but are interpreted at runtime. The interpreter (parser) of the web browser interprets and executes client-sided scripts and special software interprets and executes server-sided scripts.

1.9.7 Multi-tier

The term, multi-tier, is mostly applied to e-Commerce and business applications that are divided into function and access levels. In this study the term is applied to an application that has four different components. The application has two different interfaces, each with a specific function. The application has a database back-end that functions as a content storage object (the primary object) and a data transfer object (the secondary object), that facilitates data transfer between different tiers.

Each component or tier has its own function and the products of their functions tie them together into an application.

1.9.8 Open Database Connectivity (ODBC)

ODBC is an Application Programming Interface (API) that allows a programmer to abstract a programme from a database. When writing code to interact with a database, code must be able to “talk” (reference) to that particular database. This code is in the form of proprietary language and it is specific for a specific brand of database. If a programme needs to “talk” to different databases like Access, Fox and Oracle databases, the programme must have the propriety code for each database. Through the ODBC interface it is not necessary to include the propriety code for each brand of database, since the interface handles the references to the different databases.

1.9.9 Server-sided commands

Server-sided commands refer to commands that are interpreted by special software, like Internet Information Server from Microsoft (IIS) on the server where the web page is stored. The commands are executed before the web page is downloaded to the client's computer.

1.9.10 Structured Query Language (SQL)

SQL allows one to pose complex questions to a database, to extract data from the database and to place the data into a report. It also provides a means of creating database. Many database products support SQL. SQL works with relational databases where data are stored in different tables, the database then is the collection of the different tables.

1.10 ARRANGEMENT OF THE REPORT

Details of the study: the rationale for the development, the architecture of the application, as well as the implementation and evaluation of the multi-tier web-based application will be reported as follows.

This chapter, **Chapter 1, Orientation and background**, provides a brief introduction to, and background of the study. Apart from establishing the problem, aim and objectives of the study, it orientates and sensitises the reader to trends in CAL.

Chapter 2, Trends in computer-assisted learning, contains a report on the literature survey. This chapter will establish the motivation for the study. Positive as well as negative aspects in CAL literature will be discussed to give a holistic view on the topic.

Chapter 3, Methods, is a brief summary of the research design. A short report on the evaluation questionnaires and observation of the lecturers of the MEE 113 module is provided.

Chapter 4, Building the tiers, focuses on the development of the tiers in the web-based application. There are four tiers in the application, namely the primary interface, the primary object, the secondary object, and the secondary interface. The development of each of these will be explained separately as far as architecture, programming technique and function are concerned.

Chapter 5, Unifying the tiers, shows how the separate tiers are united to form the web-based application and explains how the application is applied to content management and content presentation in the histology module MEE 113 of the M.B.Ch.B. programme of the University of the Free State.

Chapter 6, Results, contains the recorded data from the Questionnaires and Observation Checklist. Data are reported as frequencies, and in the same format as the questionnaires.

Chapter 7, Discussion and recommendations, is devoted to a discussion of the solution that the study has accomplished. Recommendations from the action research observations, where applicable, are discussed. Further development is suggested.

1.1 CONCLUSION

The described multi-tier web-based application enables the population of a dedicated CAL presentation (JavaScript slide show) with content from an ODBC database. Quality control and management of content are much easier and placed in the hands of the lecturers, without the implication that the lecturers must be competent in programming. Learners have no more reason to mistrust the content in the JavaScript slide shows, indicating a permanent solution to the problem and enhancement of the education process in the MEE 113 module.

CHAPTER 2

TRENDS IN COMPUTER-ASSISTED LEARNING (CAL)

2.1 INTRODUCTION

Chapter 2 is a summary of the literature survey regarding the study. It will establish motivation for the study. To reach a holistic view on the subject, positive as well as negative aspects of CAL in literature will be discussed. This survey concentrates on new trends regarding the development of CAL courseware as discussed in literature. Literature regarding web development forms part of the discussion to explain the chosen developmental and delivery environment.

Views regarding the role that advances in and the availability of technology play in the educational field vary from being cautiously optimistic to intolerance of the subject. Literature on CAL does not seem to satisfy the question of "Does it work or not?" in a straightforward way. Most literature focuses on the problems of integrating technology into a field where many variables exist.

2.2 BACKGROUND

Though this survey focuses on trends regarding development, pedagogy and instructional design in CAL, literature does suggest benefits rising from the use of CAL courseware.

Sheremetov and Guzmán Arenas (2002:161) state that "virtual teaching, integrating computer and communication technologies in different educational scenarios, is advocated as a solution to the problem of exponential growth of knowledge in the contemporary society." The reality is that there are many different scenarios, each with its own problem in need of its own solution. Furthermore, to use technology to deliver vast amounts of information to learners does not constitute teaching. The delivery of knowledge or information is, however, an important part of education.

If utilised properly, CAL has benefits in the educational field and learners stand to gain most from these benefits. Carr-Chellman and Duchastel (2000:232) suggest two important reasons to use CAL in courseware. The first is due to the flexibility of CAL material or courseware, learners are able to access learning material at their own time, pace and place and, secondly, learners have control of their own learning.

In most surveys where learners had to rate CAL courseware, the above mentioned reasons were very high in importance, but other benefits of

CAL includes the development of self-motivation, independent learning and time management skills (Boudinot & Martin, 2001:9).

2.3 TRENDS IN COMPUTER-ASSISTED LEARNING (CAL)

Current trends in CAL focus on delivery environment (media), embedded pedagogy and instructional design. The following literature summary is divided into these topics.

2.3.1 Delivery environment

The development of CAL programmes today tends to be towards delivery in a web environment (Rushby, 2000a:183). The most important reasons for this are the capabilities that a web environment has in data collection, interactivity and presentation (Senese et al., 2000:s.p.), as well as connectivity and data-sharing across different platforms and centres (Jones, 2000:4).

The web environment today is more than a plain HTML (Hypertext Markup Language) environment where interaction is confined to navigation of predetermined links. Scripting languages like JavaScript and Vbscript in their environments (PHP and ASP) make it easy to build integrated database-driven web-based applications (Jones, 2000:4; Lerdorf & Tatroe, 2002:Preface).

A problem associated with web-based information, is content management (Berk, 2003:s.p). This is not restricted to educational information, but applies in general to all web content. Berk (2003:s.p) states that the essential goals of successful web content management are to lend structure to content, to support pre-existing processes and to separate content from presentation.

The integration of databases into web pages facilitates the separation of content from presentation and enhances the process of content management. Applications, developed in this way, behave in a truly dynamic way; the displayed content can be selected by the client or the developer, the way the content is displayed can vary by selection or by predetermined variables; and content can be updated in real time, because it is database bound and not part of the HTML code of the web page.

Another negative side to CAL in a web environment is availability. The number of people connected to the Internet is quoted to be very high, but studies in countries like the United States of America and the United Kingdom show that there is a divide between people that can afford and those that cannot (Reuters News Service, 2000:s.p). This is in countries where free Internet access is a reality (Rushby, 2000a :183). The problem escalates in underdeveloped countries.

Computer ownership, or at least unrestricted access to a computer, Internet connection and computer literacy are key factors in the delivery of instruction via the World Wide Web.

2.3.2 Pedagogy

An important trend in the development of CAL material is the tendency to base the development on sound educational and pedagogical principles, as opposed to simply bombarding learners with content in a web environment.

Literature suggests that this trend is currently not well enough established. Dalgarno (2001:192) believes that there is still far too much web-based learning material that is just converted from printed form to electronic form and, according to him, much is not based on any pedagogical assumptions.

The debate regarding the behaviourist (learning through repetition) versus the constructivist (learning through the construction of knowledge from information/facts) model reins in CAL as well.

Dalgarno (2001:192) argues that the level of interactivity of the web environment does facilitate the development of learning material based on a constructivist model. Carr-Chellman and Duchastel (2000:232) caution that it might be prohibitively expensive to base all CAL material on a

constructivist model. They advise lecturers and designers to choose a mixture of behaviourist and constructivist learning experiences in the development of CAL material.

Dalgarno (2001:185) strengthens his argument by giving different examples of CAL environments based on the subdivisions of the constructivist model by Moshman. The three subdivisions are:

- endogenous constructivism;
- exogenous constructivism; and
- dialectical constructivism.

2.3.2.1 *Endogenous constructivism*

Endogenous constructivism emphasises the individual nature of each learner's knowledge construction process and suggests that the teacher acts as facilitator of experiences that challenge the learner's existing models.

Hypertext and hypermedia environments that allow the user to explore information in a controlled way; and micro-worlds and simulations that allow active exploration of a virtual world are examples that Dalgarno (2001:186) gives of CAL material based on endogenous constructivism.

2.3.2.2 *Exogenous constructivism*

Exogenous constructivism is the view that formal instruction, in conjunction with exercises requiring learners to be cognitively active, can help them to form knowledge presentations, which they can later apply to realistic tasks.

CAL material that is based on exogenous constructivism will give learners control over sequence and/or give learners context-sensitive pedagogical guidance. Exercises and quizzes that give learners feedback on their own construction of knowledge are more examples of exogenous constructivism CAL material (Dalgarno, 2001:187).

2.3.2.3 *Dialectical constructivism*

Dialectical constructivism is the view that learning occurs through realistic experience, but that learners require scaffolding providing by teachers or experts, as well as collaboration with peers.

Dialectical constructivism emphasises social interaction, co-operation and collaboration with peers and experts in knowledge acquisition. Discussion boards and electronic mail (e-mail) can be used to achieve this interaction (Dalgarno, 2001:190).

2.3.3 Instructional design

Discussion in literature regarding instructional design is usually closely linked to pedagogical issues and some authors regard it as the same concept. There are, however, authors who take time to discuss instructional design in CAL. All agree that, to place digitised paper-based lectures and notes on-line, does not constitute the creation of successful CAL material (Carr-Chellman & Duchastel, 2000:229; Cronje, 2001:241; Rushby, 2000b:275).

Rushby (2000b:275) believes that not all commercial firms specialising in educational technology understand the principles of learning (**instructional**) design and would eagerly transform paper-based course material to web pages (own emphasis).

Although learning on the Internet is becoming more and more usual, it would seem that most of it still takes the form of "virtual lectures", that is to say, lecturers take their paper-based notes and convert them into text files. They also re-work their transparencies to web pages, or simply make the PowerPoint slides downloadable. Some lecturers add interactivity by running bulletin boards, or list servers. The problem with much of this is that it lacks creativity. The same boring stuff produced as lectures, become boring web pages (Cronjé, 2001:241).

To transpose traditional courses to the web environment does not utilise the on-line environment to its best advantage. Lecturers and developers should recognise that the web environment as well as on-line education is a specific medium in its own right and has its own design considerations for effective instruction (Carr-Chellman & Duchastel, 2000:229).

Hinostroza and Mellar (2001:27) indicate the importance of integrating teaching styles/methods into CAL material and not just to concentrate on learning strategies. Their idea is that a dedicated learning environment should be established, based on proven instructional design in a specific field.

Senese et al. (2000:s.p) encourage the development of dedicated applications concerning specific content. Content and field of study will dictate instructional design and each field of study requires a unique approach.

To summarise the discussion on instructional design, it is important to remember the following when CAL material/environment is developed:

- Learners must be able to relate to the CAL environment.
- The CAL environment must be stimulating.
- The CAL environment should not merely be a digitised version of a paper-based course.
- Objectives must be stated clearly in the environment.

- The CAL environment must be able to satisfy the objectives.

2.4 SUMMARY

Motivation for the study needed to be established by means of the literature survey. The following aspects had to be motivated:

- The web environment of the application.
- The dedicated presentation interface.
- The separation of content from the presentation interface.
- The establishment of a content management interface.

The literature discussed suggests that dedicated web-based CAL material indeed is the order of the day. The goal of using CAL material should be to enhance the learning experience. Learners should relate to the environment and CAL must stimulate the learning process. CAL must be based on sound pedagogical and instructional designs. The process of content management must be effective and therefore content and display should be separated.

Literature does suggest caution and adherence to pedagogical and instructional models and calls on teachers and designers alike to be creative when designing CAL material.

CHAPTER 3

METHODS

(STUDY DESIGN AND EVALUATION)

3.1 INTRODUCTION

Chapter 3, Methods, deals with the scope of study and the study design of the research project. The programming methodology is discussed in **Chapter 4, Building the tiers**, and in **Chapter 5, Unifying the tiers**.

This chapter focuses on the use of the multi-tier application to manage histology content in the JavaScript slide shows and describes the scientific process of evaluating the application. The evaluation of the application is through participant observation in an action research methodology. Reports in this study are limited to the first spiral of the action research cycle.

As discussed in 1.2 and 1.3 the study was aimed at establishing a solution to a problem encountered with content management in a JavaScript slide show CAL application, that forms part of a module on histology in the undergraduate medical education (M.B.Ch.B) programme.

Both lecturers in the module concerned, MEE 113, participated by completing questionnaires on basic computer skills, and on the functionality of the multi-tier application. Furthermore, the lecturers were observed while they completed various content management tasks according to a checklist compiled by the developer. This process aims to gain knowledge and insight into the real world situation where the application functions, and to adapt the application if necessary to enhance its function in the module MEE 113 (*cf* Mouton 2001:150-151).

3.2 STUDY DESIGN AND METHODS

3.2.1 Study design

Research design or study design is the planning of a study (Leedy, 1997:93). It provides the framework for collecting the data, and a format that describes the steps in the research process. An action research design is used for applied research that focuses on finding a solution to a local problem (Leedy, 1997:111).

The study design of this study is in the form of participatory action research to evaluate the multi-tier application as used by the lecturers in the module MEE 113 to manage the histology content in the CAL slide shows. The study design falls within the broad definition of action research described by Altrichter, Kemmis, McTaggart and Zuber-Skerritt (2002:130). The study involved research, development, intellectual

inquiry, reflection and action to improve a teaching tool in the module MEE 113. The process in the participant action research model applied to the study was as follows (*cf* Altrichter et al., 2002:125-131):

- planning and development of the application,
- implementing the application,
- observing of the lecturers as evaluation of application,
- reflecting on the observation, and
- implementing changes to improve the application.

3.2.2 Methods

Research methodology has two primary aims, namely to guide and control data acquisitions and to extract meaning from the data (Leedy, 1997:9). Methods used in this study were a selective literature survey, a study of web development techniques, development of a multi-tier web-based application on the basis of the information collected and the evaluation of the result. This falls within the ambit of action research.

According to Landman (1988:51) action research is undertaken by persons that are involved in the development of a solution for a specific problem. Action research specifies that the results need to be implemented to resolve a specific situation (Verma & Beard, 1981:178). In action research the solution of a specific problem/situation does not have to be evaluated against an external standard (Huysamen, 1998:176).

The end result of this study was the developed multi-tier web-based application to resolve the problem concerning the content management, in the computer-assisted learning part of the Module MEE 113. The success of the application was evaluated in terms of the ability of the lecturers, in MEE 113, to manipulate the content in the JavaScript slide shows through the multi-tier web-based application.

3.2.3 Study population and study sample

The study population is the lecturers in the MEE 113 module. Both lecturers were included (purposive sampling [Huysamen, 1998:44]) to evaluate the success of the application. The constant was the involvement of the lecturers, as content experts, and as such the study sample may be regarded as highly representative and may be easily duplicated in other studies.

3.3 DATA COLLECTION

Evaluation of the application was done by means of the completion of questionnaires by the study sample and by means of an observation of the study sample. The observation was scheduled after the lecturers had become acquainted with the application.

Before the observation the lecturers completed a questionnaire on computer competency (Appendix A, Questionnaire 1). The observation

focused on five specific areas of content management in the application. A checklist was used during the observation (Appendix A, Observation Checklist). The Observation Checklist enabled the observer to guide the lecturers through the five specific areas of content management. Strict adherence to the checklist ensured unbiased reproducibility of content management scenarios for each lecturer.

After the observation the lecturers were given the opportunity to rate the application in terms of ease of use and clarity by completing a second questionnaire (Appendix A, Questionnaire 2).

The developer of the multi-tier web-based application compiled the questionnaires and the checklist. The involvement of the developer in this regard falls within the ambit of participatory action research, as described by Altrichter et al. (2002:130), where participants (the researchers) in a study formulate questions and gather data themselves. On the same grounds the developer was the primary researcher and the observer in the study.

The questionnaires and checklist deal with issues as listed below:

- Questionnaire 1, Computer competency of the lecturers.
- Questionnaire 2, Evaluation of the application by the lecturers.
- Observation Checklist, Content management in the application.

3.3.1 Questionnaire 1: Computer competency

The lecturers involved in the module MEE 113 were asked to indicate what computer applications they used daily and evaluate their competency in the applications that they used.

The lecturers completed the questionnaire in person and separately from one another. Questionnaire 1 focused on the following areas:

- Microsoft Windows
- Microsoft Office
- Internet Browser
- Programming and web development.

3.3.2 Observation Checklist: Content management

The Observation Checklist was used to create content management scenarios, and the lecturers had to follow the scenarios by executing the various functions in the application. Their ability to use the functions, as well as their understanding of the outcome of the specific functions, was annotated by the observer on the checklist. The observation took place in the participants' offices. Each lecturer had to:

- navigate the content menu,

- edit descriptive text in the primary object,
- delete images and descriptive text from the primary object,
- add a new image and descriptive text to the primary object, and
- select slides to be displayed to learners in the slide show.

3.3.3 Questionnaire 2: Evaluation by lecturers

This questionnaire focused on evaluation of the application by lecturers. Each lecturer completed his/her own questionnaire in person directly after the observation had taken place.

Questions in this questionnaire focused on:

- understanding the different tiers and their functions,
- display issues, and
- perceived value.

3.4 PILOT STUDY

A pilot study, to evaluate the questions in Questionnaire 1, was conducted. To receive thorough feedback, Questionnaire 1 was piloted with two lecturers in the Faculty of Health Sciences at the UFS.

Both agreed that the questions and instructions in Questionnaire 1 were clear and that they understood and answered all questions. One person

indicated the need for an extra option between '**once a week**' and '**daily**' in questions 1.3.1, 1.3.2, 1.3.4 and 1.3.5. The option of '**more than once a week**' was added.

Since Questionnaire 2 and Questionnaire 3 dealt with the application, they were not piloted.

3.5 ETHICS

The study received approval of the Ethics Committee of the Faculty of Health Sciences at the University of the Free State. The Ethics Committee reference number is **ETOVS 139/01**.

3.6 DATA ANALYSIS

As this study can be categorised as falling within the cadre of the qualitative approach, the data collection was dependent on the researcher's personal involvement (*cf* Leedy, 1997:107). An inductive form of analysis was used whereby particular cases were observed. Inductive reasoning emphasises 'after-the-fact explanation' (Leedy, 1997:107); in this study a theory about the product emerged after careful consideration of the evidence gained from the questionnaires and observation. This theory and evidence will be applied to enhance the multi-tier web-based application.

Data are reported as frequencies since there are only two participants. The results are reported in Chapter 6.

3.7 SUMMARY

Chapter 3, Methods, discussed the study design and methodology of collecting and analysing data. The study design was in the form of participant action research. The study involved research, development, inquiry, reflection and action to improve the multi-tier web-based application as a teaching tool in the module MEE 113. The process in the participant action research model applied to the study was as follows (*cf* Altrichter et al., 2002:125-131):

- planning and development of the application,
- implementing the application,
- observing the lecturers as evaluation of application,
- reflecting on the observation, and
- implementing changes to improve the application.

Reporting on data (in **Chapter 6, Results**) and the discussion of data (in **Chapter 7, Discussion and recommendation**) are limited to the first spiral of the action research cycle.

CHAPTER 4

BUILDING THE TIERS

4.1 INTRODUCTION

The programming objective of the study was to establish a web-based application that would allow fast and simple management of histology content on the one hand, as well as the presentation of the content, in a dedicated presentation page, on the other hand. The solution had to take into account that the persons responsible for the content management, might have limited computer skills.

This chapter focuses on the development of the web-based application. There are four tiers in the application, **the primary interface, the primary object, the secondary object and the secondary interface**. The development of each of these will be explained, as far as architecture, programming technique and function are concerned.

The multi-tier concept facilitates the building of different components of the application for specific needs. Each component has its own function and the products of their functions tie them together into an application. The specific needs are the following:

- Interface for content navigation, content management and content selection – the primary interface
- Content storage object – the primary object
- Interface for content presentation – the secondary interface
- Data vehicle to transfer selected content between the primary interface and the secondary interface – the secondary object.

Figure 4.1 is a graphical display of the multi-tier web-based application that depicts the interaction and content transfer between the four tiers.

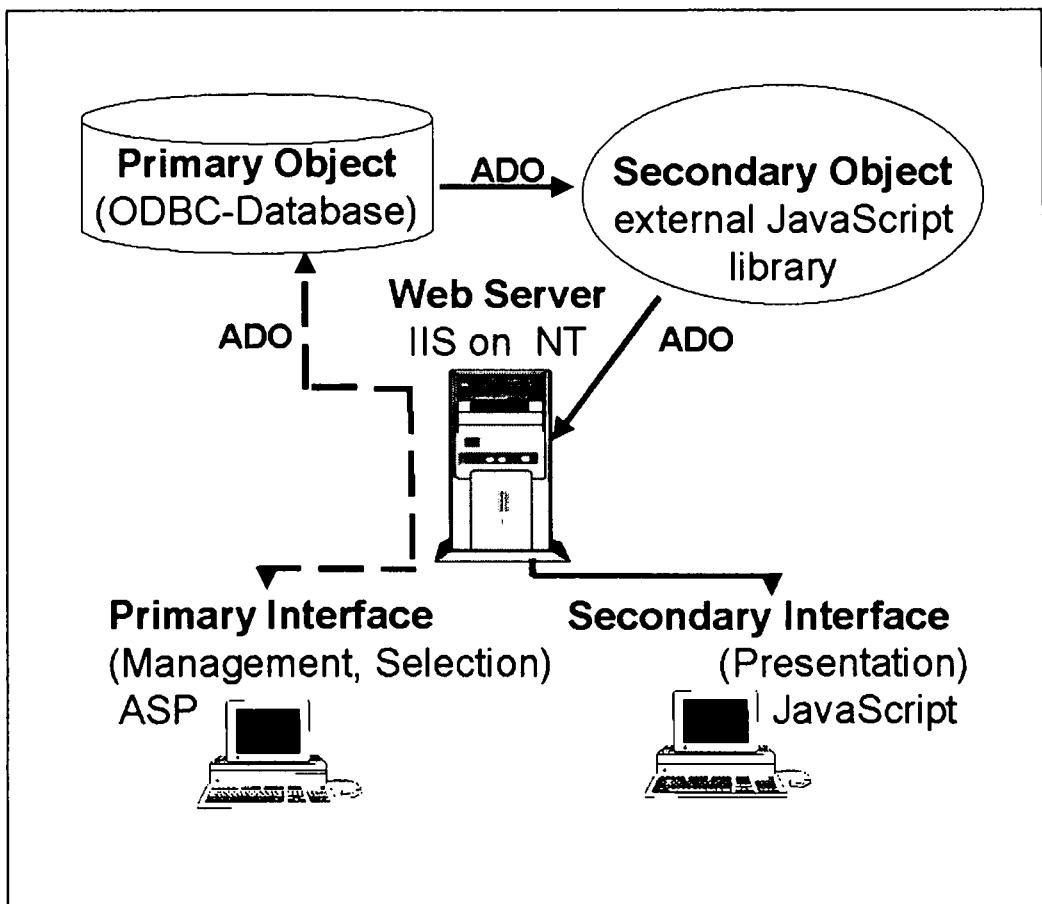


Fig. 4.1 Graphical display of the multi-tier web-based application

4.2 THE FOUR TIERS

4.2.1 Primary interface

The primary interface consists of ASP web pages and facilitates content management. The three main functions that facilitate content management in the application are:

- navigation of the content organised in lecture topics,
- manipulation of the content in the primary object, like edit, add and delete, and
- selection of specific content to be displayed to learners.

The primary interface references and displays data from an ODBC database, the primary object. Referencing of the database is established through ActiveX Data Objects commands (ADO) inserted into the ASP pages. These establish a connection to the database while a SQL statement selects the data from the database. The data are then displayed in an ASP page where content management takes place.

The first level in the primary interface deals with navigation of the content. The content is organised into lecture topics and exists as separate tables in the primary object. The navigation function is established through hyperlinks, named as the lecture topics, to the different tables in the primary object.

Manipulation and modification of the content are done through edit-, add- and delete-functions. These functions are provided through server-sided scripts. ADO middle-ware ensures that any changes to the data in the primary interface are transferred back to the primary object (database) that resides on the server. These functions are provided to facilitate the management of subject content, specifically towards correctness and enhancement.

A selection function is provided, to facilitate the selection of specific data to be displayed to learners, in the secondary interface. This selection is done on a separate ASP page. This page references the database, and generates and inserts a checkbox for each record that is displayed from the database. The checkbox is selected with a mouse click. ADO middle-ware saves the selection to an external JavaScript library file, the secondary object, which has a unique name. The unique name is generated from the specific lecture topic in the primary interface.

The proper extension of Internet Information Server needs to be installed on the web server in order to display the ASP pages and for the ADO middle-ware to function properly.

4.2.2 Primary object

The primary object acts as content storage object and is an ODBC database. The application uses a Microsoft Access database. The primary object resides on the web server and access to it is gained

through the primary interface. Content is sorted into lecture topics and each topic's content is stored in a separate table in the primary object (database). Each table represents a different slide show and each record in the table represents a specific slide in the slide show.

The content in the records is stored in fields and represents the specific image references and the descriptive text for each image in the slide show. The descriptive text is divided into an identification of the image, a description and explanation of structures in the image, a reference to the atlas, a reference to the text book, a reference to the practical guide and a reference to a microscope slide box.

The primary object does not contain the images, just their reference names. The reason is that web pages only include image references and not actual images. The images are downloaded as separate entities when the web pages are displayed. The images needed in the application reside in the same directory as the primary object on the web server.

4.2.3 Secondary object

The secondary object functions as data vehicle between the primary object and the secondary interface. The secondary object is an external JavaScript library file. It contains the selected records from the selection page in the primary interface as content data. The content data are automatically formatted into arrays by the ADO middle-ware. The arrays

are then saved as the external JavaScript library file with a unique name. The name is generated from the specific lecture topic in the primary interface. The secondary interface references this library and the slide show is populated with the content from the arrays. The secondary object has a further objective, namely to act as a security gate to the content in the primary object. Learners only see content from the secondary object and do not have access to the primary object. This ensures that only lecturers can change content.

4.2.4 Secondary interface

The secondary interface is a dedicated page to present histology content to learners in the form of interactive JavaScript slide shows. The secondary interface is a client-sided application. Everything that the slide show needs to function is transferred to the learner's computer and the scripts are executed on that computer.

The content in the JavaScript slide show (descriptive text and image references) is stored as JavaScript arrays. The arrays are saved as an external JavaScript library file, the secondary object. When the learner requests the page, the external JavaScript library file, and the HTML code, containing the JavaScripts are downloaded to the learner's computer. The slide show is then populated with content from the secondary object that resides on the client's computer.

The slide show outlay provides simultaneous view of the image with its descriptive text at a screen resolution size of 800 x 600 dpi. Navigation buttons are placed under the image and facilitates rotation through the slides and requests for descriptive text. Images are only downloaded to the client-side, after a rotation has been requested. This is the only network traffic that takes place after the initial page download.

A pre-load function, to download all the images at once, when a request to the page is made, may be added. Since some of the slide shows contain a large amount of images, it was deemed counter productive and left out.

4.3 SUMMARY

The programming objective of the study was to establish a web-based application that would allow fast and simple management of histology content on the one hand, as well as the presentation of the content in a dedicated presentation page, on the other hand. The solution had to take into account that the persons responsible for the content management might have limited computer skills.

Chapter 4 described the four tiers in the application, **the primary interface, the primary object, the secondary object and the secondary interface** in terms of architecture and specific function. **Chapter 5, Unifying the tiers**, explains how the different tiers are tied together to form the application.

CHAPTER 5

UNIFYING THE TIERS

5.1 INTRODUCTION

Unifying the tiers shows how the separate tiers are united to form the web-based application and explains how the application is applied to content management and content presentation in the histology module MEE 113 of the M.B.Ch.B. programme of the University of the Free State.

The Module MEE 113 of the M.B.Ch.B. programme in the School of Medicine, at the University of the Free State, deals with tissues of the body and focus is placed on histology as content. A web-based JavaScript slide show engine was developed to give learners the opportunity to extend contact time with learning material in a structured way, but without the time constraints of normal classes. Images with descriptive text form the basis of the slide show engine; the learner can move through images (forward and backward) in the slide show with interactive buttons. The content of the slide show (image reference and descriptive text) is stored in JavaScript arrays.

At first it was envisaged that the lecturers would be in charge of the content after it had been placed in the arrays, but editing the arrays

proved time consuming and beyond the programming skills of the lecturers.

The main objective of the application was to simplify the management of content in the JavaScript slide shows. The content in the JavaScript slide shows is placed in arrays to facilitate rotation through the content. Content management means the editing of these arrays and the application simplifies this through an interface dedicated to content management.

5.2 CONTENT MANAGEMENT

The first and foremost need for content management is to have content stored in an object that is accessible, not only to read from, but to write to as well. The application uses Microsoft Access, an ODBC database as storage object. The database is the primary tier in the application and is called the primary object.

Content management takes place in the primary interface. The primary interface is a collection of ASP web pages that references the primary object, reads the content from the database and displays the content in the ASP web pages.

5.2.1 Navigation of lecture topics – primary interface

Content management starts with the navigation of the different lecture topics in an ASP web page, the content menu page. The content menu page has hyperlinks to the different lecture topics. The links, when selected, reference the primary object on the server, select the corresponding table and read all the records from the table. These records are then displayed in an ASP web page for further manipulation and modification as discussed in 5.2.2.

The content menu page can be seen in figure 5.1.

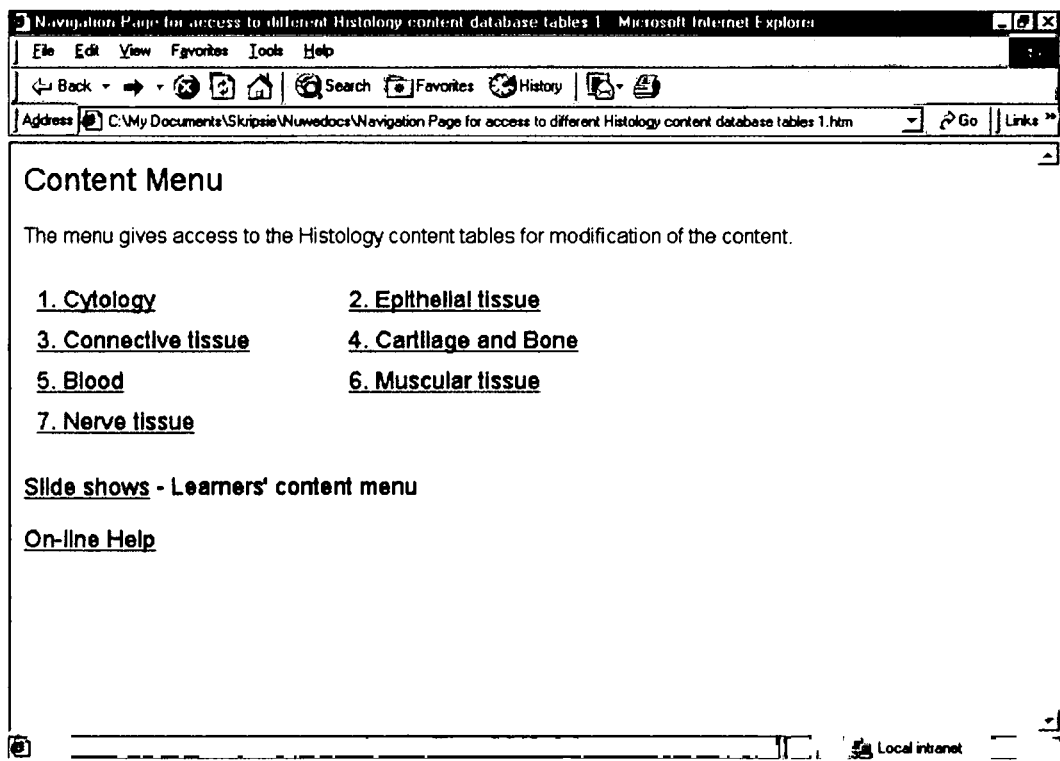


Fig. 5.1 View of the content menu page

5.2.2 Content modification – primary interface

The ASP web page, where content modification takes place, references a specific table in the database (according to a selected lecture topic in the content menu page) and reads all the records from the table. The records are displayed in typical database column-row format where the columns represent the different fields in the database and the rows represent the records. The borders of the fields and records are set by HTML table code. Each record represents a specific slide in the slide show.

The following fields are displayed:

- Index = the identification number of the record in the database
- Img name = the name and extension of the specific image
- Image = displays the specific image as a thumbnail
- Counter = a number to identify the records/slides by
- Identification = short identification of the slide
- Description = description of histology structures in the image
- Atlas = reference to the learners' atlas
- Text Book = reference to the learners' text book
- Practical Guide = reference to the learners' practical guide
- Slide Box = reference to slide box at microscope
- Delete = a hyperlink to the delete-function
- Edit = a hyperlink to the edit-function.

At the end of the display there is a hyperlink to execute the add-function.

The edit-, the delete- and the add-functions enable the modification of the content in the primary object. The three functions are discussed below.

The described outlay of the primary interface can be seen in figure 5.2.

Primary Interface: Edit, Delete & Add Cytology content in the Histology database

[Edit](#); [Select](#); [Slide Show](#); [Homepage](#)

Index	Image name	Image	Counter	Identification	Description	Atlas	Text Book	Practical Guide	Slide Box	Delete	Edit
2	si1.jpg		1	Mitosis: Anaphase	Chromosomes at opposite poles of cells	p35 fig 2.3b	none	Practical 2 no 2	86	Delete	Edit
6	si5.jpg		2	Fat cells	Large non-stained cells with central area of lipid. Thin rim of cytoplasm on periphery. One nucleus per cell on periphery.	p70 fig 4.11	p 31	Practical 2 no 4	74	Delete	Edit

[Add a Record](#)

Fig. 5.2 View of the modification page in the primary interface

5.2.2.1 Edit-function

The edit-function opens an ASP web page with text boxes that represent the specific record's fields in the database table. Editing takes place in these text boxes. Spelling and ambiguous statements can be rectified and

description/discussions as well as image references can be changed. When editing is completed, a submit-button (marked 'Update' in the ASP page), linked to ADO commands and SQL statements, transfers the new data to the primary object and refreshes the display of the table in the primary interface. If an image reference is changed, the new image will be displayed when the page is refreshed, provided the image is uploaded to the server beforehand.

The text box page can be seen in figure 5.3.

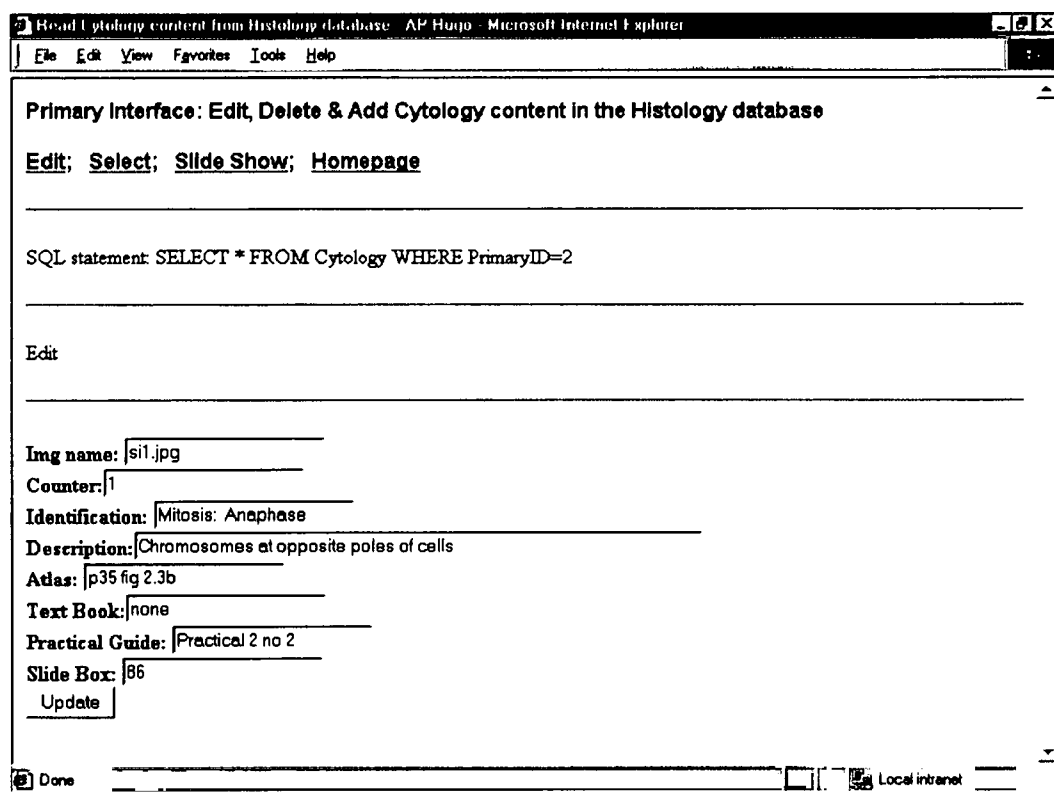


Fig. 5.3 View of the text box page in the primary interface where editing take place

5.2.2.2 Delete-function

The delete-function enables the deletion of a complete record from the primary object. This is an extreme modification, but it does not remove the actual image from the server, because it is possible to use the same image in different slide shows. ADO commands and SQL statements ensure the deletion in the primary object.

5.2.2.3 Add-function

The add-function ensures the addition of new records (slides) to the primary object. This function opens an ASP page with text boxes corresponding to empty fields of a new record in the primary object. Content is placed in the text boxes and a submit-button (marked 'Update' in the ASP page), linked to ADO commands and SQL statements transfers the data of the new record to the primary object and refreshes the display of the table in the primary interface.

It is imperative that the correct number is placed in the counter field, ensuring that the new record is placed at the bottom of the display. The correct number would be the number in the counter field of the last record plus 1. To facilitate the selection of the correct number, the add-function is placed at the bottom of the display. The add-function does not allow empty fields, all text boxes must contain information or the add-function will not be completed. This ensures that additions of new records are

complete. The image of the new record will be displayed when the page is refreshed, provided the image is uploaded to the server beforehand.

If a new addition includes a new image, the image must be uploaded to the server via a File Transfer Protocol (FTP) application of preference.

Figure 5.4 shows the addition page in the primary interface.

Primary Interface: Edit, Delete & Add Cytology content in the Histology database

[Edit](#); [Select](#); [Slide Show](#); [Homepage](#)

Add

Img name:

Counter:

Identification:

Description:

Atlas:

Text Book:

Practical Guide:

Slide Box:

Done Local intranet

Fig. 5.4 View of the addition page in the primary interface

Content modifications apply only to the content stored in the primary object. The modifications do not reflect automatically in the secondary interface. A special selection-function in the primary interface ensures the transferral of new content to the slide shows.



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5.2.3 Selecting content

It is important that modifications to the primary object are also reflected in the slide shows. New content must be transferred from the primary object to the JavaScript arrays, in the secondary object. This is accomplished through an ASP page, the selection page in the primary interface. The records in the specific table are read and displayed in the ASP page in the same manner as in the modification page. A selection box is generated for each displayed record and can be selected with a mouse click. This ensures that content/records can be marked as selected.

The outlay of the selection page is depicted in figure 5.5.

Selection page: Lecturer select content from Primary Object to be displayed in Secondary Interface

[Edit](#); [Select](#); [Slide Show](#); [Homepage](#)

Index	Image name	Image	Selection	Check box	Counter	Identification	Description	Atlas	Text Book	Practical Guide	Slide Box
2	si1.jpg		True	<input checked="" type="checkbox"/>	1	Mitosis: Anaphase	Chromosomes at opposite poles of cells	p35 fig 2.3b	none	Practical 2 no 2	86
6	si5.jpg		False	<input type="checkbox"/>	2	Fat cells	Large non-stained cells with central area of lipid. Thin rim of cytoplasm on periphery. One nucleus per cell on periphery.	p70 fig 4.11	p 31	Practical 2 no 4	74

Select

Done Local intranet

Fig. 5.5 View of the selection page in the primary interface

When the selection is completed, a submit-button (marked 'Select' in the ASP page), linked to ADO commands, formats the selected records into JavaScript arrays. The ADO middle-ware writes these arrays to an external JavaScript library file, the secondary object that acts as data vehicle between the primary object and the secondary interface. Each slide show has its own secondary object or JavaScript library file, identified by a unique name that corresponds with the slide show topic. Modified or updated content can be placed in the arrays that populate the JavaScript slide shows, in secondary interface, via the selection page and the secondary object.

The JavaScript arrays in the secondary object can be seen in figure 5.6.

```

Building the JavaScript arrays - Microsoft Internet Explorer
File Edit View Favorites Tools Help

Edit; Select; Slide Show; Homepage

cytology.js

var fotos=new Array()
var which=0
fotos[0] = " si1.jpg"
fotos[1] = " si5.jpg"

var fs=new Array()
var which=0
fs[0] = " 0"
fs[1] = " 1"

var ID=new Array()
var which=0
ID[0] = "Mitosis: Anaphase"
ID[1] = "Fat cells"

var rede1=new Array()
var which=0
rede1[0] = "Chromosomes at opposite poles of cells"
rede1[1] = "Large non-stained cells with central area of lipid. Thin rim of cytoplasm on periphery. One nucleus per cell on periphery."

var a=new Array()

```

Fig. 5.6 Definition and population of the JavaScript arrays

5.3 CONTENT PRESENTATION

Content presentation to learners takes place in the secondary interface via the JavaScript slide show engine. There are two parts to the secondary interface: the first part enables the navigation of the lecture topics and gives access to the second part, the actual slide shows.

5.3.1 Navigation of lecture topics in the secondary interface

Navigation of the different lecture topics is just as important in the presentation side as in the management side (see 7.4.2.1 for discussion). Navigation of the topics is established by links in a content menu page, named as lecture topics that point to the different slide shows. This page looks similar to the content menu page of the lecturers (Fig. 5.1). Both the learners and the lecturers have access to this page.

5.3.2 The slide shows

Content presentation is through the JavaScript slide show engine. The slide shows have different components, the content components and the navigation components. The outlay of the different components of the slide show, on the page, is done in HTML code. All the components are visible on a browser page if the screen resolution is set to 800 x 600 dpi (see 7.4.2.5 for discussion).

The different components of the slide show are depicted in figure 5.7.

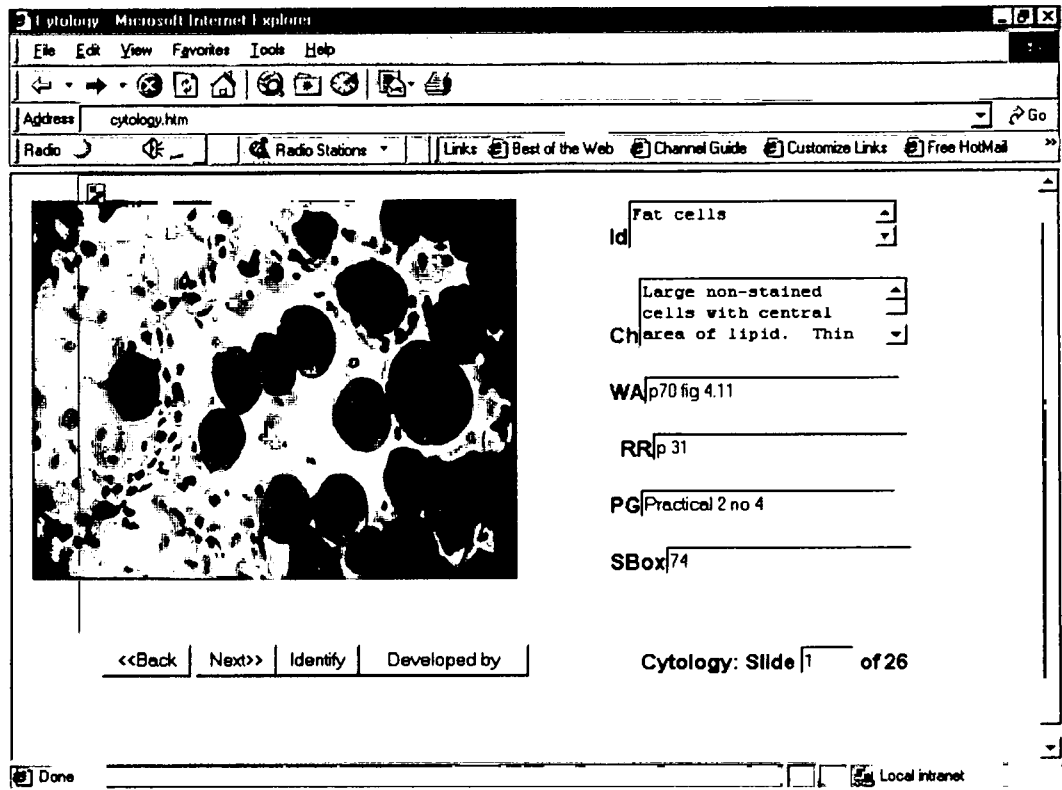


Fig. 5.7 View of the secondary interface

5.3.2.1 Content components

The content components are the image area, the identification box, the description/discussion box and the three reference boxes. These content components represent the different fields of the tables, in the primary object. Each slide represents a specific record in the primary object.

The content components are populated with content from the JavaScript arrays in the secondary object.

5.3.2.2 *Navigation components*

The navigation components in the slide show are interactive buttons located directly under the image area. These buttons ensure forward and backward rotation of images in the slide show. The descriptive text is not presented initially on rotation; it must be requested by clicking an interactive button, the Identification-button (see 7.4.2.3 for discussion).

5.4 SUMMARY

The four different tiers are unified through the products of their functions. The primary object, as back-end database for content storage, is the heart of the application. The primary interface is closely tied to the primary object, because it reads from, and writes to, the database. The secondary interface does not have any direct connection to either the primary object or the primary interface. A product from a function in the primary interface, the secondary object, ties the secondary interface to the application. Thus the functions of the different tiers establish the application.

CHAPTER 6

RESULTS

6.1 INTRODUCTION

In this chapter the results of the applications' evaluation are reported. Results are reported as frequencies and listed in the questionnaire format. The results are reported in the chronological, recorded order. Questionnaire 1 was completed by the lecturers first, then followed the Observation Checklist, completed by the observer, and Questionnaire 2 was completed by the lecturers last.

6.2 QUESTIONNAIRE 1: COMPUTER COMPETENCY

Participating lecturers completed Questionnaire 1 in person, directly before the observation took place. They had to rate their skills and abilities in computer applications that they use daily to fulfil their duties.

Areas that were rated, include:

- Microsoft Windows
- Microsoft Office
- Internet Browser
- Programming and web development.

1.1 SKILLS IN WINDOWS	
1.1.1 RATE YOUR ABILITY TO NAVIGATE TO PROGRAMMES ON YOUR COMPUTER.	FREQUENCY
a. None	0
b. Poor	0
c. Good	2
d. Excellent	0
1.1.2 RATE YOUR ABILITY TO NAVIGATE TO DIFFERENT FOLDERS/DIRECTORIES ON YOUR COMPUTER.	FREQUENCY
a. None	0
b. Poor	0
c. Good	1
d. Excellent	1
1.1.3 RATE YOUR ABILITY TO COPY FILES TO DIFFERENT FOLDERS/DIRECTORIES ON YOUR COMPUTER.	FREQUENCY
a. None	0
b. Poor	0
c. Good	2
d. Excellent	0
1.2 SKILLS IN MS OFFICE	
1.2.1 RATE YOUR SKILL IN MS WORD.	FREQUENCY
• THE USE OF MS WORD TO ONLY COMPOSE LETTERS RATES POOR	
• THE USE OF MS WORD TO COMPOSE STUDY GUIDES RATES EXCELLENT	
a. None	0
b. Poor	1
c. Good	1
d. Excellent	0
1.2.2 RATE YOUR SKILL IN CREATING POWERPOINT SLIDES.	FREQUENCY
a. None	0
b. Poor	0
c. Good	2
d. Excellent	0
1.2.3 HOW OFTEN DO YOU USE POWERPOINT SLIDES DURING LECTURES?	FREQUENCY
a. Never	0
b. Seldom	1
c. Often	1
d. Always	0
1.2.4 RATE YOUR SKILL IN THE DEVELOPMENT OF MS ACCESS DATABASES.	FREQUENCY
a. None	1
b. Poor	1
c. Good	0
d. Excellent	0
1.2.5 RATE YOUR SKILL IN THE UPDATING OF ESTABLISHED MS ACCESS TABLES.	FREQUENCY
a. None	0
b. Poor	1
c. Good	1
d. Excellent	0

1.3 USE OF INTERNET	
1.3.1 HOW OFTEN DO YOU USE (SURF) THE INTERNET AS A RESOURCE TO ENHANCE YOUR WORK? (RESEARCH, TRACKING NEW DEVELOPMENT, INVESTIGATION OF RESOURCES)	FREQUENCY
a. Never	0
b. Seldom	1
c. Bi-weekly	1
d. Once a week	0
e. More than once a week but not daily	0
f. Daily	0
1.3.2 HOW OFTEN DO YOU USE (SURF) THE INTERNET FOR RECREATIONAL PURPOSES? (HOBBIES, NEWS, PRIVATE TRAVEL AND DESTINATIONS)	FREQUENCY
a. Never	0
b. Seldom	1
c. Bi-weekly	0
d. Once a week	1
e. More than once a week but not daily	0
f. Daily	0
1.3.3 CAN YOU IDENTIFY LINKS IN A WEB PAGE?	FREQUENCY
a. Yes	2
b. No	0
1.3.4 HOW OFTEN DO YOU RECEIVE ELECTRONIC MAIL (E-MAIL)?	FREQUENCY
a. Never	0
b. Seldom	0
c. Bi-weekly	0
d. Once a week	0
e. More then once a week but not daily	0
f. Daily	2
1.3.5 HOW OFTEN DO YOU SEND ELECTRONIC MAIL (E-MAIL)?	FREQUENCY
a. Never	0
b. Seldom	0
c. Bi-weekly	0
d. Once a week	0
e. More than once a week but not daily	1
f. Daily	1
1.4 PROGRAMMING AND WEB DEVELOPMENT EXPERIENCE	
1.4.1 DO YOU HAVE ANY PROGRAMMING EXPERIENCE?	FREQUENCY
a. Yes	0
b. No	2
1.4.2 DO YOU HAVE ANY WEB DEVELOPMENT EXPERIENCE?	FREQUENCY
a. Yes	0
b. No	2
1.4.3 DO YOU KNOW WHAT A JAVASCRIPT ARRAY IS?	FREQUENCY
a. Yes	1
b. No	1

1.4.4 WOULD YOU BE ABLE TO LOCATE A JAVASCRIPT ARRAY ON YOUR OWN IN THE DEVELOPED APPLICATION?	FREQUENCY
a. Yes	1
b. No	1
1.4.5 IF THE RESPONSE TO QUESTION 1.4.4 WAS 'YES' WOULD YOU BE ABLE TO EDIT THE ARRAY?	FREQUENCY
a. Yes	0
b. No	1

6.3 OBSERVATION CHECKLIST: CONTENT MANAGEMENT

The Observation Checklist was compiled by the developer and used by the observer, to create content management scenarios. The lecturers had to complete the various content management tasks in the scenarios. The observer noted and annotated the checklist accordingly. Specific functions and actions were as follows:

- Navigation of the content menu
- Editing of descriptive text
- Deletion of slides
- Addition of slides
- Selection of specific slides to be displayed in the secondary interface.

1.1 NAVIGATION OF THE CONTENT MENU	
1.1.1 CAN THE LECTURER DESCRIBE THE FUNCTION OF THE CONTENT MENU?	FREQUENCY
a. Yes	2
b. No	0
1.1.2 CAN THE LECTURER SUCCESSFULLY NAVIGATE THE CONTENT MENU?	FREQUENCY
a. Yes	2
b. No	0

1.2 EDITING OF DESCRIPTIVE TEXT IN THE PRIMARY INTERFACE	
1.2.1 CAN THE LECTURER DESCRIBE THE DIFFERENCE BETWEEN THE PRIMARY OBJECT AND THE PRIMARY INTERFACE?	FREQUENCY
a. Yes	1
b. No	1
1.2.2 CAN THE LECTURER IDENTIFY CONTENT OF A SPECIFIC SLIDE IN THE PRIMARY INTERFACE?	FREQUENCY
a. Yes	2
b. No	0
1.2.3 CAN THE LECTURER EDIT THE DESCRIPTIVE TEXT OF A SPECIFIC SLIDE SUCCESSFULLY?	FREQUENCY
a. Yes	2
b. No	0
1.3 DELETION FROM THE PRIMARY OBJECT	
1.3.1 CAN THE LECTURER DELETE A SPECIFIC SLIDE SUCCESSFULLY?	FREQUENCY
a. Yes	2
b. No	0
1.4 ADDITIONS TO THE PRIMARY OBJECT	
1.4.1 CAN THE LECTURER ADD A SLIDE TO THE PRIMARY OBJECT?	FREQUENCY
a. Yes	2
b. No	0
1.5 SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS	
1.5.1 CAN THE LECTURER DESCRIBE WHY IT IS NECESSARY TO MAKE A SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS IN THE SECONDARY INTERFACE?	FREQUENCY
a. Yes	1
b. No	1
1.5.2 CAN THE LECTURER MAKE A SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS IN THE SECONDARY INTERFACE?	FREQUENCY
a. Yes	2
b. No	0

6.4 QUESTIONNAIRE 2: EVALUATION BY LECTURERS

In Questionnaire 2, lecturers had the opportunity to evaluate the application. Questions focused on clarity and understanding of the functions and tiers, as well as on display issues and perceived value.

2.1 UNDERSTANDING THE DIFFERENT TIERS				
2.1.1 MATCH THE FUNCTIONS LISTED AS 1 – 4 TO THE DIFFERENT TIERS IN a - d. CIRCLE YOUR CHOICE OF FUNCTION NUMBER FOR EACH TIER. NUMBER FUNCTION 1. CONTENT TRANSFER BETWEEN TIERS 2. CONTENT MODIFICATION AND SELECTION 3. CONTENT STORAGE 4. CONTENT DISPLAY TO LEARNERS				
	1	2	3	4
	FREQUENCY			
a. Primary object	0	0	2	0
b. Primary interface	0	2	0	0
c. Secondary object	2	0	0	0
d. Secondary interface	0	0	0	2
2.1.2 ARE THE FUNCTION INDICATORS IN THE PRIMARY INTERFACE INTUITIVE / DESCRIPTIVE ENOUGH?				FREQUENCY
a. Yes				2
b. No				0
c. Uncertain				0
2.1.3 IF ANSWER TO 2.1.2 WAS NO PLEASE COMMENT				FREQUENCY
Comment:				0
2.2 DISPLAY ISSUES				
2.2.1 IS THE DISTINCTION BETWEEN CONTENT OF DIFFERENT SLIDES IN THE PRIMARY INTERFACE CLEAR ENOUGH?				FREQUENCY
a. Yes				2
b. No				0
c. Uncertain				0
2.2.2 IF ANSWER TO 2.2.1 WAS NO PLEASE COMMENT				FREQUENCY
2.2.3 Comment:				0
2.2.3 IS THE DISTINCTION BETWEEN THE DIFFERENT CONTENT LEVELS (IMAGE NAME, IDENTIFICATION, DESCRIPTIVE TEXT AND REFERENCES) IN THE PRIMARY INTERFACE CLEAR ENOUGH?				FREQUENCY
a. Yes				2
b. No				0
c. Uncertain				0
2.2.4 IF ANSWER TO 2.2.3 WAS NO PLEASE COMMENT				FREQUENCY
Comment:				0

2.2.5 RATE THE INFORMATION DISPLAY IN THE SECONDARY INTERFACE (THE SLIDE SHOW) REGARDING THE USE IN INSTRUCTIONAL/EDUCATIONAL PURPOSE. (SIZE, POSITION AND FUNCTION, DO NOT RATE IMAGE QUALITY).	FREQUENCY
a. Poor	0
b. Adequate	0
c. Good	1
d. Excellent	1
2.2.6 RATE THE GENERAL IMAGE QUALITY OF THE HISTOLOGY IMAGES REGARDING INSTRUCTIONAL/EDUCATIONAL QUALITY IN THE SECONDARY INTERFACE (SLIDE SHOW).	FREQUENCY
a. Poor	0
b. Adequate	0
c. Good	2
d. Excellent	0
2.3 PERCEIVED VALUE	
2.3.1 DOES THE CONTENT MANAGEMENT SIDE OF THE APPLICATION ADD VALUE TO THE INSTRUCTIONAL QUALITY OF THE SLIDE SHOW?	FREQUENCY
a. Yes	2
b. No	0
c. Uncertain	0
2.3.2 IF ANSWER TO 2.3.1 WAS NO PLEASE COMMENT	FREQUENCY
Comment:	0
2.3.3 IS THE CONTENT MANAGEMENT INTERFACE (PRIMARY INTERFACE) USERFRIENDLY?	FREQUENCY
a. Yes	2
b. No	0
c. Uncertain	0
2.3.4 IF ANSWER TO 2.3.3 WAS NO PLEASE COMMENT	FREQUENCY
Comment:	0
2.3.5 DOES THE CONTENT MANAGEMENT INTERFACE (PRIMARY INTERFACE) HAVE ADEQUATE FUNCTIONS FOR YOU AS LECTURER TO MANAGE THE CONTENT OF THE SLIDE SHOWS?	FREQUENCY
a. Yes	2
b. No	0
c. Uncertain	0
2.3.6 IF ANSWER TO 2.3.5 WAS NO PLEASE COMMENT	FREQUENCY
Comment:	0

2.3.7 Do YOU HAVE ANY OTHER COMMENTS OR SUGGESTIONS?	FREQUENCY
Comment: Lecturers should be able to select where additions to the primary object are placed, presently additions are placed at the end of the database table. If it is possible lecturers will be able to create a sequence of a specific slide at different magnifications. An option to search the entire database on keywords.	 1 1

6.5 SUMMARY

The reported results are from the questionnaires and checklist, compiled by the developer. The questions were specifically formulated to establish a reference of individual computer competency for the participating lecturers, to observe the lecturers while they completed various content management tasks, and to give the participating lecturers the opportunity to evaluate the application. Discussion of the results forms part of **Chapter 7, Discussion and recommendations.**

CHAPTER 7

DISCUSSION AND RECOMMENDATIONS

7.1 INTRODUCTION

Chapter 7 is devoted to a discussion of the solution that the study accomplished. General ideas on the embedded pedagogy and design considerations are mentioned. Results from the questionnaires and the checklist are discussed. Recommendations regarding further development are given, and the actions that will be taken to complete the first spiral of the participatory action research methodology are discussed.

7.2 EDUCATIONAL CONTEXT OF APPLICATION

7.2.1 General

Historically a lot of emphasis was placed on histology slides in the second year of the previous M.B.Ch.B. programme of the University of the Free State. Histology was a two-semester course and recognition of histology images (normal tissue versus pathological tissue) and knowledge of physiological processes in the body was deemed necessary to pass the subject. Learners were assessed by means of spot recognition tests and examinations as well as by written theory tests and examinations.

A teaching strategy of the lecturers in the course, to boost knowledge retention and improve marks, was to review sets of 35mm slides of histology images before major assessments. The lecturers helped learners revising the work by identifying the tissue and specific structures according to specific characteristic features. The UFS has a parallel medium teaching policy and the lecturers had to present each set at least twice (once in Afrikaans and once in English). If learners could not attend one of the revision sessions, time was always found to schedule an extra session. The JavaScript slide show was developed to replace this practice with a more flexible method to enable the learners to access the content in their own time and at their own rate.

At the particular time the UFS, as a higher educational institution, was conducting an investigation into Learning Management Systems (LMS). Although not committed to a particular one, at the time, it was deemed appropriate to acquire a web-based LMS. The development of the JavaScript slide show was undertaken, with the possibility in mind for it to be accessible from the foreseen web-based LMS.

In 2000 a new M.B.Ch.B. programme was initiated at the UFS. The programme follows an integrated and learner-centered approach. Learners now spend more time working on their own, acquiring the knowledge that was previously given via lecturing. Lecturers have less time to help learners with revision, because of management and facilitation processes, which render the new M.B.Ch.B. programme much

more labour intensive than the old programme. The JavaScript slide show is a valuable resource in the new M.B.Ch.B. programme towards histology tutoring. The resource is flexible and learner-centered. Learners are able to access the histology content in their own time, at their own rate and it is not restricted to a specific classroom. Learners may access the resource from any computer that have an Internet connection.

The evolution of the multi-tier application changed the JavaScript slide show's application from a revision tool in the old M.B.Ch.B. programme to an instructional tool for use in the new M.B.Ch.B. programme. The multi-tier application further dispels the mistrust learners have regarding the correctness and expertness of the content, by involving the lecturers as content experts in the management of the content.

The technology necessary for the multi-tier application to function correctly may not be accessed from the LMS of choice (WebCT Campus Edition) at the UFS. The application presently resides on a web server. This enhances sharing of content across different year groups, as in a spiral of learning methodology. Content may be shared between different learning programmes as well. If the content were part of WebCT Campus Edition, this would not have been possible. Learners access the content from within a WebCT course, each year and programme groups have their own WebCT course; the content though, is the same as there is only one application to which the different WebCT courses are linked.

7.2.2 Primary interface

The primary interface is a content management interface. The importance of this interface is that it enables the lecturers, as content experts, to take charge of content management in the multi-tier CAL application. Neither programming skills, nor web development skills need to be acquired to manage the content. The general computer skills that the lecturers have, are more than sufficient to accomplish the content management tasks.

The involvement of the lecturers as content experts in the application indicates to learners the correctness and the importance of the content. Lecturers are able to adapt content to suit a much bigger application than without the content management side, for example the content was primarily developed to be applicable to the M.B.Ch.B. programme, but of late the application is used by the B. Med.Sc. and Optometry learners at the UFS as well.

7.2.3 Secondary interface

The function of the secondary interface, the JavaScript slide show in the educational environment is to offer flexible and extended contact time to learners in the Module MEE 113 with histology content. The secondary interface, being a web-based application offers just that. Learners may access the slide shows at any time and from any computer connected to the Internet.

7.3 PEDAGOGY

7.3.1 M.B.Ch.B. programme at UFS

The new M.B.Ch.B. programme at the UFS is an integrated and learner-centered programme. Although one still finds a legacy of instructivism and behaviourism in the applied pedagogy, most modules in the programme are based on constructivism.

7.3.2 JavaScript slide show in MEE 113

The CAL material in the module MEE 113 at the UFS on first scrutiny seems to be built on a behaviourist model, but a closer look will reveal it to be more of an exogenous and dialectical constructivist nature.

7.3.2.1 *Instructivism and behaviourism*

The JavaScript slide shows display pre-determined content to learners and as such it might be viewed as based on an instructivist model. The slide shows give learners the opportunity to view the same material repeatedly, and thus it can be viewed to have a behaviourist undertone. Both are true, but the built-in functions of the slide show and the peer environment in which the slide shows are applied, lend a constructivist tone to it.

7.3.2.2 Constructivism

The JavaScript slide shows give learners the opportunity to engage in a learning environment where they can discuss displayed content with peers. This practice is actively encouraged in the M.B.Ch.B. programme at the UFS. Learners are randomised into groups at the beginning of the first year. They are encouraged to work and learn together. Time for group activities such as directed learning and self-directed learning are scheduled for learners in the modules. In the module MEE 113 learners are given the opportunity during both directed and self-directed learning to access the JavaScript slide shows in the computer room at the Faculty of Health Sciences, UFS. This time is spent in the assigned groups and therefore encourages peer learning.

The JavaScript slide shows give learners the opportunity to test their own acquired knowledge against an expert facilitator, the computer, by not displaying the descriptive text of the slides on the initial display of the image. Learners must request it with an interactive button, the Identification-button. The descriptive text is expert knowledge compiled by the lecturers in the module MEE 113. Learners have the opportunity to construct even more knowledge by following the references to their Atlas, Text book, Practical Guide and slide box given in the slide shows.

7.4 DESIGN CONSIDERATION

Design considerations in both the primary interface and the secondary interface are discussed. Design considerations in the primary interface focus on ease of use and clarity in the demarcation of the content. Design considerations in the secondary interface focus more on instructional design and embedded pedagogy.

7.4.1 Primary interface

7.4.1.1 *Navigation*

Confidence is built when navigation is easy and clear. The outlay of the first page in the application was designed as a content menu, according to the lecture topics in the MEE 113 module of the M.B.Ch.B. programme of the UFS (Fig. 5.1). The lecture topics are hyperlinks to the primary interface; each hyperlink extracts content from that specific lecture topic's database table into the primary interface. Navigation to the different content is thus according to lecture context and easy and clear to use.

The content menu page contains a link called 'Slide shows' that gives easy access to the content menu page that the learners see. From here the lecturer may view the slide shows per lecture topic.

Navigation in the content management pages, the primary interface, is also quite easy (Fig. 5.2). All navigational links are placed as a banner at the top of the pages. The links are named according to their functions, for example, the Edit-link will take one to the editing page in the primary interface, the Select-link will take one to the selection page in the primary interface, and the Slide show-link will take one to the slide show. The navigation in the application is thus intuitive, clear and easy.

The different functions like the edit-function, the delete-function and the add-function are clearly visible as well. Each record has a 'edit' and 'delete' hyperlink. The add-function is placed at the bottom of the primary interface.

7.4.1.2 Column-row format

The aim of the application is to establish a simple content management interface. All content related to a specific lecture topic and the functions needed to execute content management should therefore be visible on the same page. The column-row format of the primary interface places all content and functions on one page (Fig. 5.2).

Demarcation of content is clear, as borders between the columns and rows are thick and easy to spot. Each row in the display represents a specific slide in the corresponding slide show.

7.4.2 Secondary interface

Design considerations in the secondary interface focused mostly on embedded pedagogy and instructional design, but also on clarity and ease of use.

7.4.2.1 *Navigation of lecture topics*

The content that is displayed in the secondary interface is structured into lecture topics. The first page that learners access, is structured as a content menu. The content menu contains hyperlinks, indexed according to the lecture topics, to the different slide shows. This page looks similar to the content menu page of the lecturers as in Fig. 5.1. The content menu and the hyperlinks give learners quick reference to the different lecture topics and easy access to the slide shows. The lecture topics are covered in formal lectures. Therefore the secondary interface places the content in the same context as the formal lectures.

Currently, learners get access to the content menu page from a WebCT course. Learners are thoroughly primed on the use of WebCT and the secondary interface at the beginning of their first academic year. Navigation to WebCT and subsequently to the content menu is easy and clear.

7.4.2.2 Navigation in slide show

Navigation in the slide show is easy with the aid of three buttons, placed directly under the image (Fig. 5.7). The buttons are labelled, **Back**, **Next** and **Identify**. This clearly states their function.

Most discussions in the discussion text box are longer than the 3 lines provided in the discussion box. The identification and the discussion text boxes have scrollbars to facilitate the reading of the long discussions.

7.4.2.3 Identification-button

One of the navigation buttons in the slide show is the Identification-button (Fig. 5.7). The identification and discussions of an image do not appear on the rotation of the image. A learner must request it by pressing the Identification-button. This enhances the learning experience in the slide show. It turns each image in the slide show into a potential formative test, with instant feedback in the form of expert knowledge from a dedicated facilitator, the computer.

7.4.2.4 Text boxes

The text boxes in the slide shows contain information on the specific image (Fig. 5.7). The information in the identification and in the discussion text boxes is core knowledge. The reference text boxes refer learners to

more detailed knowledge in their prescribed text book, atlas and practical guide. These references help in constructing the theoretical knowledge. The reference to the slide box in the microscopy room encourages learners to experience histology through a microscope as well.

The lecturers in the module, the content experts, generated all information in the text boxes. Therefore, the information can be seen as expert knowledge. The computer acts as a dedicated and expert facilitator in knowledge construction.

7.4.2.5 *Display - 800 x 600 dpi*

The secondary interface was developed to display all information on a single web page at a screen resolution of 800 x 600 dpi (Fig. 5.7). All navigation buttons, the image and the text boxes are visible without the need to scroll the web page at this setting. The image area is big enough to clearly display the images. The identification and discussion text boxes have their own scrollbars to facilitate the reading of long discussions. This way only the text in the text box is scrolled and not the whole page, the image, the navigation buttons and the text boxes are always visible on the same page.

7.5 EVALUATION DISCUSSION

The results from the evaluation process reported in **Chapter 6, Results**, are discussed in this section.

7.5.1 Questionnaire 1: Computer competency

This questionnaire aimed to establish a reference for each participating lecturer with regard to basic computer competency and focused on:

- Microsoft Windows
- Microsoft Office
- Internet Browser
- Programming and web development.

7.5.1.1 *Basic skills in MS Windows and MS Office*

The participating lecturers rated their abilities and skills in MS Windows, and MS Office on average, as good to excellent. They indicated no or poor skills regarding the creation of a database table, and one was not too optimistic about his ability to update an MS Access database table created by someone else (see 6.2). The development of a database table is regarded as an advanced skill and not a basic computer skill.

7.5.1.2 *Internet and e-mail use*

Both lecturers indicated that they receive and send e-mails regularly. Neither indicated a high frequency use of the Internet as a resource in their work and only one indicated frequent Internet use for recreational purposes. Still both indicated confidence in their ability to identify and navigate links in a web page (see 6.2).

It is clear that neither lecturer is daunted by the Internet as a resource and they see it as 'just another programme' to be used. Both indicated, during discussions, that time is the restrictive factor in their Internet usage and not ability or fear.

7.5.1.3 *Programming and web development*

Neither lecturer indicated any programming or web development experience. One lecturer indicated that he knew what a JavaScript array was, and that he would be able to locate one in the developed application. He did not believe that he would be able to edit the array, though (see 6.2). This could mean that the lecturer mistook 'locate' for 'identify', that is, if he was presented with a printout or screen view of the source code, he would be able to identify the JavaScript array, and not that he would be able to open the source code by himself.

7.5.1.4 Summary: Questionnaire 1

From the questionnaire it is clear that the participating lecturers are quite competent in basic computer skills. They do not feel confident in more advanced skills like, database development and neither have any programming or web development skills. They do not use the Internet much because of time constraints but they are capable of identifying and navigating links in a web page.

The computer skills of the lecturers indicate that they are quite capable of using the multi-tier application.

7.5.2 Observation Checklist: Content management

The Observation Checklist enabled the observer to recreate the same content management scenarios for each lecturer. Lecturers had to:

- navigate the content menu,
- edit descriptive text in the primary object,
- delete images and descriptive text from the primary object,
- add a new image and descriptive text to the primary object, and
- select slides to be displayed to learners in the slide show.

7.5.2.1 *Navigation of content menu*

Both lecturers could describe the function of the content menu and both were able to navigate to the primary interface of the different lecture topics (see 6.3).

7.5.2.2 *Modification; edit, add, delete*

Although one lecturer could not describe the difference between the primary object and the primary interface, both could indicate the content associated with a specific slide in the primary interface (see 6.3). It is more important to be able to associate content with a specific slide than to understand the way the application functions in the background.

The scenarios created for content editing, content addition, and content deletion were completed successfully by both lecturers (see 6.3).

7.5.2.3 *Selection*

In describing the function of selecting content in the primary interface to be displayed in the secondary interface, one lecturer was not quite on the mark, but both were capable of selecting specific content to be displayed in the secondary interface. Although it was not required in the content management scenario, both lecturers navigated to the slide show after the selection was completed and viewed their selections in the slide show.

7.5.2.4 Summary: Observation Checklist

One lecturer could not confidently answer the questions regarding the background functioning of the application, but never the less both completed the content management scenarios successfully.

Argument for not comprehending the background functions of the application was given by the lecturer as having a greater concern regarding the execution of the content management functions than understanding the background functions of the application. Since the particular lecturer was able to complete the content management scenarios successfully, the argument may be seen as valid.

7.5.3 Questionnaire 2: Evaluation by lecturers

This questionnaire focused on evaluation of the application by lecturers. Each lecturer completed his/her own questionnaire in person directly after the observation took place.

Questions in this questionnaire focused on:

- understanding the different tiers and their functions,
- display issues, and
- perceived value.

7.5.3.1 *Understanding the different tiers and functions*

Both lecturers were able to match the different tiers to specific functions correctly in the questionnaire (see 6.4). This seems to contradict results recorded in Questionnaire 1 and Observation Checklist regarding the functioning of the application. The difference may be that the preceding content management scenarios clarified the tiers and functions to the lecturer who was uncertain when completing the previous questionnaire.

The lecturers indicated that the functions (edit, add and delete) in the primary interface are intuitive and descriptive enough. The functions are labelled 'edit', 'delete' and 'add a record', thus it is not surprising that they believe it to be descriptive enough.

7.5.3.2 *Display issues*

The distinctions of content between slides and between content levels in the primary interface were adequate to both lecturers (see 6.4). The column-row format in the display facilitates this distinction in a simple and intuitive way.

The lecturers rated the information display (size, position and function) in the secondary interface, regarding educational purposes, as good to excellent. They were also quite pleased with the image quality achieved in the secondary interface.

7.5.3.3 *Perceived value*

The lecturers believe that the content management side of the application enhances the educational value of the slide show. The lecturers agree that the management of content by content experts enhances the trust that learners place in the content, and that this builds confidence to use the application as learning resource.

The lecturers indicated that the primary interface are user friendly and they were satisfied that there are adequate content management functions built into the primary interface to successfully manage the content.

At the end of the questionnaire lecturers were invited to make a comment or suggestion regarding the application. Two comments/suggestions were made.

The first comment was regarding the addition of content (see 6.4). One of the lecturers suggested that additions should not be placed by default at the end of the database, rather he wants to choose the specific place where it must be inserted. This will enable the lecturer to build slide sets of different magnifications of the same microscope slide in the database. Since the arrays that populate the slide shows are built from top to bottom from the selections, the slides in a set should follow one another.

The second comment suggested that a search option with a dedicated keyword field in the database should be added to the application (see 6.4).

7.5.3.4 Summary: Questionnaire 2

The participating lecturers indicated confidence in the use of the application to manage the content in the slide shows, and that this will lead to greater acceptance and trust in content amongst learners. Both suggestions made by the lecturers are valid requests that will enhance the application's function as a content management interface, and time will be made to fulfil these requests.

7.6 FUTURE DEVELOPMENT

Being web-based, the application functions in a dynamic and ever changing environment. The application must fulfil the needs of the users, the lecturers and learners, in an equally dynamic and changing educational environment. Both the web environment and the educational environment dictate adaptation and further development for sustainable use. The study design of the study was deliberately chosen as participant action research to continuously evaluate and adapt the application for sustainable future use.

7.6.1 Action research recommendations

The first development will be to satisfy the requests made by the lecturers in the evaluation process. The request that the lecturer should be able to select the place where addition of new content is inserted into the database, will receive attention first. The search option and dedicated keyword field in the database will receive attention as well.

7.6.2 Open source environments

Universally there is a greater acceptance of open source environments today than two to three years ago. This is the trend at the UFS as well. The UFS decided to change from a Windows NT web server to a Linux and Apache web server. This makes it necessary to change the application from ASP source and MS Access as database to PHP as source and MySQL as database, since ASP cannot run natively on Linux and Apache.

Presently the Windows NT server at the UFS continues to operate, but no further maintenance or upgrades will be done on the machine. The change to PHP source will be completed by mid-2004. The change to PHP source and MySQL as database will not influence or restrict the current use of the application.

Although it seems a lot of work to change to the PHP and MySQL environment, the implementation of the application will not be restricted to a Linux and Apache platform, because PHP and MySQL can be installed on a Windows platform as well. The initial development should have been in PHP, but policy at the UFS at that time did not favour open source development.

7.6.3 Secondary object

The secondary object, an external JavaScript library file, is a crucial tier in the application. It acts as data vehicle between the primary object (database) and the slide show, but it is not dynamic. Data are placed into the secondary object by selection of data in the primary interface. Until data are selected, no changes are made to the data in the secondary object.

Future development in the application will focus on the possibility of refreshing the secondary object from the database each time a slide show is requested by a learner. In the ASP and MS Access environment this was not an option as simultaneous connection to the MS Access database is limited, but in a PHP and MySQL environment such limitations do not exist and it would be attainable. The secondary object and data flow will then become dynamic in the application.

7.6.4 On-line help

Although neither of the participating lecturers requested it, it was decided to give users access to the **User manual** as an on-line resource.

7.7 SUMMARY

The multi-tier web-based application was developed as a resource regarding histology content in the module MEE 113 of the M.B.Ch.B. programme at the UFS. This chapter discussed the application in terms of educational context, pedagogy, instructional design, evaluation of the application and future development. The lecturers in the module MEE 113 view the application as a resource with great potential. The evaluation of the application should be expanded to include the learners as well.

7.8 CONCLUSION

I trust that the development, implementation and evaluation of the multi-tier web-based application will make a contribution to the education of histology in the module, MEE 113, of the M.B.Ch.B. programme of the UFS. The scope of use has already increased through the implementation of the application in the B.Med.Sc. and Optometry programmes at the UFS.

Despite positive feedback from all parties involved, the study does have limitations. The first limitation identified is in the literature reference on content management. In the e-learning environment, it is generally perceived that Content and Learning Management Systems (CLMS) should take care of content management issues. Literature dealing with dedicated developed applications does not discuss content management issues (cf. Hinostroza & Mellar, 2001:27-40; Senese *et al.*, 2000:s.p). Literature regarding content management in general web development is mostly technical and dedicated towards operating platforms, databases and development environments. Currently though, it has been established that content management issues are resolved when data and display are separated (Berk, 2003:s.p). This is the way content management was resolved in this study as well.

I would like to encourage Health Professions education providers, through this study, to find solutions through in-house development and evaluation of home-grown CAL applications to the complex problem of having to cope with commercial CAL applications which do not suit the specific need for which they had been acquired.

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APPENDIX A

**Evaluation of the multi-tier web-based
application:**

**Questionnaires
&
Observation Checklist**

November 2003

COMPILED BY:

Alwyn Hugo

Dear Colleague

I trust you are aware of the participative action research project regarding the development and the use of multi-tier web-based computer-assisted learning application in the module, MEE 113. Since you are a lecturer in the module, I would appreciate your participation in the application's evaluation.

The application's evaluation will include the following:

- Questionnaire 1: Computer Competency of Lecturer
- Observation Checklist: Content management
- Questionnaire 2: Evaluation of Application by Lecturer

You, the lecturer must complete Questionnaire 1, that will establish an individual computer competency reference.

The Observation Checklist is a structured checklist. An observer will complete it, while you, the lecturer, carry out the various content management tasks in the application according to the structured checklist.

You must also complete Questionnaire 2, and you will receive the questionnaire after the Observation Checklist has been completed. This questionnaire will give you the opportunity to rate, and to make suggestions and comments regarding the application.

All data will be treated confidentially and when reported it will not implicate or identify you as an individual in any way.

I thank you for your time, effort and participation in this project.

Regards,
Alwyn Hugo
(Student number 1984196129)

QUESTIONNAIRE 1

COMPUTER COMPETENCY

To be completed by the lecturer

Participating lecturers must complete this questionnaire. Lecturers must indicate the computer applications / programmes that they use in the execution of their duties and they must rate their competency in these applications / programmes. The following areas will be rated:

- Microsoft Windows
- Microsoft Office
- Internet Browser
- Programming and Web development

PLEASE CIRCLE YOUR CHOICE

1.1 SKILLS IN WINDOWS

1.1.1 RATE YOUR ABILITY TO NAVIGATE TO PROGRAMMES ON YOUR COMPUTER.

a. None	1
b. Poor	2
c. Good	3
d. Excellent	4

1.1.2 RATE YOUR ABILITY TO NAVIGATE TO DIFFERENT FOLDERS/DIRECTORIES ON YOUR COMPUTER.

a. None	1
b. Poor	2
c. Good	3
d. Excellent	4

1.1.3 RATE YOUR ABILITY TO COPY FILES TO DIFFERENT FOLDERS/DIRECTORIES ON YOUR COMPUTER.

a. None	1
b. Poor	2
c. Good	3
d. Excellent	4

1.2 SKILLS IN MS OFFICE

1.2.1 RATE YOUR SKILL IN MS WORD.

- THE USE OF MS WORD TO ONLY COMPOSE LETTERS RATES POOR
- THE USE OF MS WORD TO COMPOSE STUDY GUIDES RATES EXCELLENT

a. None	1
b. Poor	2
c. Good	3
d. Excellent	4

1.2.2 RATE YOUR SKILL IN CREATING POWERPOINT SLIDES.	
a. None	1
b. Poor	2
c. Good	3
d. Excellent	4
1.2.3 HOW OFTEN DO YOU USE POWERPOINT SLIDES DURING LECTURES?	
a. Never	1
b. Seldom	2
c. Often	3
d. Always	4
1.2.4 RATE YOUR SKILL IN THE DEVELOPMENT OF MS ACCESS DATABASES.	
a. None	1
b. Poor	2
c. Good	3
d. Excellent	4
1.2.5 RATE YOUR SKILL IN THE UPDATING OF ESTABLISHED MS ACCESS TABLES.	
a. None	1
b. Poor	2
c. Good	3
d. Excellent	4
1.3 USE OF INTERNET	
1.3.1 HOW OFTEN DO YOU USE (SURF) THE INTERNET AS A RESOURCE TO ENHANCE YOUR WORK? (RESEARCH, TRACKING NEW DEVELOPMENT, INVESTIGATION OF RESOURCES)	
a. Never	1
b. Seldom	2
c. Bi-weekly	3
d. Once a week	4
e. More than once a week but not daily	5
f. Daily	6
1.3.2 HOW OFTEN DO YOU USE (SURF) THE INTERNET FOR RECREATIONAL PURPOSES? (HOBBIES, NEWS, PRIVATE TRAVEL AND DESTINATIONS)	
a. Never	1
b. Seldom	2
c. Bi-weekly	3
d. Once a week	4
e. More than once a week but not daily	5
f. Daily	6
1.3.3 CAN YOU IDENTIFY LINKS IN A WEB PAGE?	
a. Yes	1
b. No	2
1.3.4 HOW OFTEN DO YOU RECEIVE ELECTRONIC MAIL (E-MAIL)?	
a. Never	1
b. Seldom	2
c. Bi-weekly	3
d. Once a week	4
e. More than once a week but not daily	5
f. Daily	6

1.3.5 HOW OFTEN DO YOU SEND ELECTRONIC MAIL (E-MAIL)?	
a. Never	1
b. Seldom	2
c. Bi-weekly	3
d. Once a week	4
e. More than once a week but not daily	5
f. Daily	6
1.4 PROGRAMMING AND WEB DEVELOPMENT EXPERIENCE	
1.4.1 DO YOU HAVE ANY PROGRAMMING EXPERIENCE?	
a. Yes	1
b. No	2
1.4.2 DO YOU HAVE ANY WEB DEVELOPMENT EXPERIENCE?	
a. Yes	1
b. No	2
1.4.3 DO YOU KNOW WHAT A JAVASCRIPT ARRAY IS?	
a. Yes	1
b. No	2
1.4.4 WOULD YOU BE ABLE TO LOCATE A JAVASCRIPT ARRAY ON YOUR OWN IN THE DEVELOPED APPLICATION?	
a. Yes	1
b. No	2
1.4.5 IF THE RESPONSE TO QUESTION 1.4.4 WAS 'YES' WOULD YOU BE ABLE TO EDIT THE ARRAY?	
a. Yes	1
b. No	2

QUESTIONNAIRE 2

EVALUATION BY LECTURERS

To be completed by the lecturers

This questionnaire focuses on the evaluation of the application by the participating lecturers. Lecturers must complete the questionnaire after the observation is complete. Questions focus on:

- Understanding the different tiers and their functions.
- Display issues.
- Perceived value.

PLEASE CIRCLE YOUR CHOICE

2.1 UNDERSTANDING THE DIFFERENT TIERS

2.1.1 MATCH THE FUNCTIONS LISTED AS 1 – 4 TO THE DIFFERENT TIERS IN a - d. CIRCLE YOUR CHOICE OF FUNCTION NUMBER FOR EACH TIER.

NUMBER FUNCTION

1. CONTENT TRANSFER BETWEEN TIERS
2. CONTENT MODIFICATION AND SELECTION
3. CONTENT STORAGE
4. CONTENT DISPLAY TO LEARNERS

a. Primary object	1	2	3	4
b. Primary interface	1	2	3	4
c. Secondary object	1	2	3	4
d. Secondary interface	1	2	3	4

2.1.2 ARE THE FUNCTION INDICATORS IN THE PRIMARY INTERFACE INTUITIVE / DESCRIPTIVE ENOUGH?

a. Yes	1
b. No	2
c. Uncertain	3

2.1.3 IF ANSWER TO 2.1.2 WAS NO PLEASE COMMENT

Comment:

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2.2 DISPLAY ISSUES	
2.2.1 IS THE DISTINCTION BETWEEN CONTENT OF DIFFERENT SLIDES IN THE PRIMARY INTERFACE CLEAR ENOUGH?	
a. Yes	1
b. No	2
c. Uncertain	3
2.2.2 IF ANSWER TO 2.2.1 WAS NO PLEASE COMMENT	
Comment:	
2.2.3 IS THE DISTINCTION BETWEEN THE DIFFERENT CONTENT LEVELS (IMAGE NAME, IDENTIFICATION, DESCRIPTIVE TEXT AND REFERENCES) IN THE PRIMARY INTERFACE CLEAR ENOUGH?	
a. Yes	1
b. No	2
c. Uncertain	3
2.2.4 IF ANSWER TO 2.2.3 WAS NO PLEASE COMMENT	
Comment:	
2.2.5 RATE THE INFORMATION DISPLAY IN THE SECONDARY INTERFACE (THE SLIDE SHOW) REGARDING THE USE IN INSTRUCTIONAL/EDUCATIONAL PURPOSE. (SIZE, POSITION AND FUNCTION, DO NOT RATE IMAGE QUALITY).	
a. Poor	1
b. Adequate	2
c. Good	3
d. Excellent	4
2.2.6 RATE THE GENERAL IMAGE QUALITY OF THE HISTOLOGY IMAGES REGARDING INSTRUCTIONAL/EDUCATIONAL QUALITY IN THE SECONDARY INTERFACE (SLIDE SHOW).	
a. Poor	1
b. Adequate	2
c. Good	3
d. Excellent	4
2.3 PERCEIVED VALUE	
2.3.1 DOES THE CONTENT MANAGEMENT SIDE OF THE APPLICATION ADD VALUE TO THE INSTRUCTIONAL QUALITY OF THE SLIDE SHOW?	
a. Yes	1
b. No	2
c. Uncertain	3

2.3.2 IF ANSWER TO 2.3.1 WAS NO PLEASE COMMENT	
Comment:	
2.3.3 IS THE CONTENT MANAGEMENT INTERFACE (PRIMARY INTERFACE) USERFRIENDLY?	
a. Yes	1
b. No	2
c. Uncertain	3
2.3.4 IF ANSWER TO 2.3.3 WAS NO PLEASE COMMENT	
Comment:	
2.3.5 DOES THE CONTENT MANAGEMENT INTERFACE (PRIMARY INTERFACE) HAVE ADEQUATE FUNCTIONS FOR YOU AS LECTURER TO MANAGE THE CONTENT OF THE SLIDE SHOWS?	
a. Yes	1
b. No	2
c. Uncertain	3
2.3.6 IF ANSWER TO 2.3.5 WAS NO PLEASE COMMENT	
Comment:	
2.3.7 DO YOU HAVE ANY OTHER COMMENTS OR SUGGESTIONS?	
Comment:	
THE END	
Thank you for your participation.	

OBSERVATION CHECKLIST

CONTENT MANAGEMENT CHECKLIST

To be completed by the observer

<p>The observer must complete this questionnaire.</p> <p>During the observation lecturers must manage content in the application by executing the various functions in the application. The lecturer's ability to use the functions and the lecturer's understanding of the outcome of the specific functions are noted with the aid of the questionnaire. Each lecturer must:</p> <ul style="list-style-type: none"> • Navigate the content menu. • Edit descriptive text in the primary object. • Delete images and descriptive text from the primary object. • Add a new record to the primary object. • Select specific slides to be displayed to learners in the slide show. 	
PLEASE CIRCLE YOUR CHOICE	
1.1 NAVIGATION OF THE CONTENT MENU	
1.1.1 CAN THE LECTURER DESCRIBE THE FUNCTION OF THE CONTENT MENU?	
a. Yes	1
b. No	2
<p>Note to observer: The content menu has links that match course topics. The links reference the primary object (database) and displays the specific topic's content in the primary interface, where modifications and selections are made.</p>	
1.1.2 CAN THE LECTURER SUCCESSFULLY NAVIGATE THE CONTENT MENU?	
a. Yes	1
b. No	2
<p>Note to observer: Lecturer's action is noted</p>	
1.2 EDITING OF DESCRIPTIVE TEXT IN THE PRIMARY INTERFACE	
1.2.1 CAN THE LECTURER DESCRIBE THE DIFFERENCE BETWEEN THE PRIMARY OBJECT AND THE PRIMARY INTERFACE?	
a. Yes	1
b. No	2
<p>Note to observer: The primary object is a database where content is stored. The primary interface displays the content in a web page where modification and selection can take place.</p>	
1.2.2 CAN THE LECTURER IDENTIFY CONTENT OF A SPECIFIC SLIDE IN THE PRIMARY INTERFACE?	
a. Yes	1
b. No	2
<p>Note to observer: The content of a specific slide is displayed as a row in the table format of the primary interface. Lecturer must be able to indicate it.</p>	
1.2.3 CAN THE LECTURER EDIT THE DESCRIPTIVE TEXT OF A SPECIFIC SLIDE SUCCESSFULLY?	
a. Yes	1
b. No	2
<p>Note to observer: Lecturer's action is noted</p>	

1.3 DELETION FROM THE PRIMARY OBJECT	
1.3.1 CAN THE LECTURER DELETE A SPECIFIC SLIDE SUCCESSFULLY?	
a. Yes	1
b. No	2
Note to observer: Lecturer's action is noted	
1.4 ADDITIONS TO THE PRIMARY OBJECT	
1.4.1 CAN THE LECTURER ADD A SLIDE TO THE PRIMARY OBJECT?	
a. Yes	1
b. No	2
Note to observer: Lecturer's action is noted	
1.5 SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS	
1.5.1 CAN THE LECTURER DESCRIBE WHY IT IS NECESSARY TO MAKE A SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS IN THE SECONDARY INTERFACE?	
a. Yes	1
b. No	2
Note to observer: Content displayed in the primary interface is stored in the primary object. Content displayed in the secondary interface is stored in JavaScript arrays (the secondary object) that are built only after a selection is made. The JavaScript arrays stay the same until a new selection is made. Modifications in the primary object are not automatically updated in the JavaScript arrays.	
1.5.2 CAN THE LECTURER MAKE A SELECTION OF SLIDES TO BE DISPLAYED TO LEARNERS IN THE SECONDARY INTERFACE?	
a. Yes	1
b. No	2
Note to observer: Lecturer's action is noted	
THE END	

APPENDIX B

USER MANUAL FOR LECTURERS

1.1 INTRODUCTION

This **User manual** gives a short but comprehensive description on the use of the application. The content management functions of the application are discussed to give an overview of content management, through the primary interface, in the application. Navigation to, and navigation in the secondary interface are explained as well.

The application established an effective, though simple, way to manage the content of a series of JavaScript slide shows that are used in the module MEE 113 of the M.B.Ch.B. programme of the University of the Free State.

The application has two interfaces: the primary interface to manage content in, and the secondary interface (the JavaScript slide show) to display content in. Each interface has its own content storage object. The primary interface stores content in a database, and the secondary interface stores content in a JavaScript library file.

Content management, as well as content display is discussed in this document.

1.2 CONTENT MANAGEMENT

In this section, navigation, content storage and content management in the primary interface are described.

1.2.1 Navigation

1.2.1.1 *Navigation to the application*

The application is web-based and thus can be reached through a web browser and the Universal Resource Locator (URL):

<http://kiewiet.uovs.ac.za/faculties/med/anatomie/hist/Navigate.htm>

The application can be accessed from the University of the Free State's main web as well. The URL is:

<http://www.uovs.ac.za>

Navigate to Faculties, to Health Sciences, to Departments, and then to the Basic Medical Sciences web page. Follow the link to the computer-assisted learning web page and then follow the link called Histology Content Management.

Any browser higher than Internet Explorer version 4 will be able to display the pages correctly. The JavaScript browser setting must be activated.

1.2.1.2 *Navigation in the application*

The first web page of the application contains the different lecture topics as hyperlinks in a menu format. These links are followed by selection with a mouse. Once selected, a new page opens, displaying all the content of that specific lecture topic that is stored in the primary object (database). The content menu page lends structure and index to the content in the primary object.

1.2.2 Content storage – primary object

The primary object is a database that holds all the content in the application. The content in the database is divided into specific lecture topics. Each topic's content is kept in a separate table in the database. Changes to the content, whether through editing, addition or deletion, are automatically saved to the database when the specific function is carried out.

1.2.3 Content management interface

The content management interface is called the primary interface. The primary interface is reached by selecting a lecture topic in the content menu page. This action opens a web page that displays all the content of the lecture topic that is stored in the primary object (database). The content is displayed in a column-row format. The primary interface

enables one to edit, add and delete content from the primary object. A special function, the selection-function, to select content to be displayed in the secondary interface (JavaScript slide show) is placed in the primary interface as well.

1.2.3.1 *Editing*

The edit-function is a hyperlink called 'Edit' in the column named Modify at the most right hand side of the display. Each record, represented by a row in the column-row display, has its own 'Edit' hyperlink. Clicking on this link opens a page that contains the image reference, and the descriptive text in text boxes.

Point and select the specific text box where modification needs to be made with the mouse. Delete the wrong text and type in the new text. Click on the Update-button when finished. An information page will display 'Operation complete' when the modification was successful and 'Operation cancelled' when unsuccessful. In both instances take the 'Edit page' link back to the primary interface or any of the hyperlinks in the top banner to the page of your choice. If the information page reported 'Operation cancelled' the update was not successful. You will need to do the changes again. If it happens regularly, contact the developer.

1.2.3.2 *Addition*

The add-function is reached via the hyperlink, 'Add a record', at the bottom of the primary interface display. Click on the link with the mouse. A page similar to the Edit page is opened, but there is no text in the text boxes. Before selecting the 'Add a record' hyperlink, note the number in the 'counter' field. You must enter this number plus 1 into the new addition's 'counter' text box.

It is imperative that text is entered into all the boxes before the Update-button is clicked. If a box does not contain any information the operation will not be completed.

If an image already resides on the server, and the correct image name is placed in the image reference box you will see the thumbnail of the image in the primary interface when the Update-button is pressed. If the image is not yet on the server you must copy it via your File Transfer Protocol (FTP) application to the server.

An information page will display 'Operation complete' when the addition was successful and 'Operation cancelled' when unsuccessful. In both instances take the 'Edit page' link back to the primary interface or any of the hyperlinks in the top banner to the page of your choice. If the information page reported 'Operation cancelled' the addition was not

successful. You will need to do the addition again. If it happens regularly, contact the developer.

1.2.3.3 Deletion

Each record has a 'Delete' link just left of the 'Edit' link. This is an extreme function; it deletes all the descriptive text as well as the image reference from the primary object. No warning is given prior to execution. The actual image is not deleted from the server, as the same image may be used in other slide shows.

An information page will display 'Operation complete' when the deletion was successful and 'Operation cancelled' when unsuccessful. In both instances take the 'Edit page' link back to the primary interface or any of the hyperlinks in the top banner to the page of your choice. If the information page reported 'Operation cancelled' the deletion was not successful. You will need to do the deletion again. If it happens regularly, contact the developer.

1.2.3.4 Selection

The primary interface has a link to the selection-function, located at the top of the display. Follow this link to select specific records from the primary object to be included in the slide show. The secondary interface, the JavaScript slide show, does not reference the primary object directly.

The content that is displayed in the JavaScript slide show is stored as an external JavaScript library file, the secondary object. The selection-function transfers the selected content from the primary object to the secondary object.

Execution of this function is necessary in two situations. First, to select specific slides to be included into the slide show, for example, you as lecturer may deem it necessary to include only certain slides to indicate the influence of a specific staining method on structures. Later you may want to include all the slides in the lecture topic and then he must execute the selection-function again.

Second, when modifications are made to content in the primary interface, only the primary object is updated. The selection-function must be executed to transfer the modifications to the secondary object for display in the secondary interface.

The selection-function opens a page similar to the main primary interface page, but each record have a selection box situated next to the thumbnail image. Click in this box to activate the selection of a specific slide. At the end of the page a Select-button appears together with a unique name that indicates the name of the external JavaScript library file. This name corresponds with the lecture topic.

When the Select-button is clicked, the JavaScript array is automatically built by ADO commands and saved as the external JavaScript library file. This file is displayed as a web page. Follow the navigational links at the top of the page to the content menu page (Homepage), to the edit page (Edit), to the selection page (Select), or to a view of the secondary interface (Slide show).

1.3 CONTENT DISPLAY

Content is displayed in the secondary interface as JavaScript slide shows. Navigation to and in the secondary interface is discussed since the lecturers need to see and experience the content from the learners' side as well.

1.3.1 Content storage – secondary object

The secondary interface does not reference the primary object directly, rather content is stored in the secondary object, an external JavaScript library file. This file is automatically built after the selection function is executed as discussed in Appendix B 1.2.3.4. The JavaScript slide show is populated by content from the secondary object when the learner requests the slide show.

1.3.2 JavaScript slide show

The JavaScript slide shows display the content in the secondary interface. Learners see a content menu page similar to the lecturers' content menu page with links according to lecture topics. These links go directly to the JavaScript slide shows.

The lecturers may view the slide shows by either following the link called 'Slide show' on top of the primary interface, or by selecting the link on the content menu page called 'Slide show'. The link on top of the primary interface will only display the specific lecture topic's slide show that was selected in the content menu page. Following the link from the content menu page will enable the lecturers to select a specific slide show from the content menu page of the learners. Always refresh the display of the slide show by pressing the F5 key on your keyboard or the refresh-button of your browser after you opened the slide show. This will place the most recent JavaScript library file (secondary object) on your computer.

1.3.2.1 *Navigation in slide show*

Navigation inside the JavaScript slide show is by navigational buttons under the image area in the slide show. Main navigational buttons are **Back**, **Next**, and **Identify**. The Back- and Next-buttons facilitate forward and backward movement through the slides in the JavaScript slide show.

The descriptive text of a slide only becomes visible after the Identify-button has been pressed.

Once all the slides have been viewed a pop-up window appears with 'Ok' and 'Cancel' options. Both options take one back to the previous page.

1.4 ON-LINE HELP

For convenience and quick reference, this document is accessible from the main content menu page. Just follow the link 'Help Manual'; the document contains a table of contents to quickly find a specific topic.

