THE DEVELOPMENT AND EVALUATION
OF AN INTERACTIVE
COMPUTER-BASED TRAINING (CBT) MODULE

by
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THESIS

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Supervisor: Prof. M Weideman

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DECLARATION

I declare that *The development and evaluation of an interactive computer-based training (CBT) module* is my own work, that it has not been submitted before for any degree or assessment in any other university or technikon, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

STUDENT:

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S Lourens
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ABSTRACT

THE DEVELOPMENT AND EVALUATION OF AN INTERACTIVE COMPUTER-BASED TRAINING (CBT) MODULE

The primary objective of this research was to establish whether or not an interactive multimedia Computer-Based Training (CBT) module could assist learners to gain an improved understanding of their learning material. CBT can be deployed as a mechanism of presenting learning material in a more original, interactive and structured way. Furthermore, CBT has the potential to enhance the learning experience of learners, and by providing stimulation to learn based on their preferred learning styles. It is of importance to note that external elements such as motivational, personal, and educational factors (e.g. previous experience of CBT and computer use) can influence learning. The secondary objective was to measure if learners will show a positive attitude/reaction towards CBT if applied to the COBOL programming language in a Development Software 1 (DOS1) programme.

A substantial number of learners fail DOS1 each year and it has become a requirement to improve the situation by enhancing learning experiences of such learners. Research has shown that learners using interactive multimedia CBT material attain a “learning advantage” over learners receiving classroom-based instruction. Little research however has been conducted in the application of CBT instruction in the teaching of programming languages.

The methods employed in this research include the development of a Macromedia Flash CBT module that supports various animations, and the evaluation of the module’s effectiveness as a method for introducing learners to the COBOL programming language. Furthermore, the effects of CBT on learners’ attitudes were evaluated.
A summative evaluation was used in an online pre-test/post-test approach to determine the effectiveness of the module. After completion of the module, a formative approach was used and the experimental group was requested to complete an online questionnaire for evaluation of the CBT module and to determine the extent of their acceptance thereof.

Results indicate that even though the experimental group (who made use of the CBT module) obtained a higher mean gain score than the control group (who received traditional classroom-based instruction), it proved to be insignificant. Gain scores between and within the two groups did not indicate any significant improvement. The results from this research returned that even though CBT instruction did not show a significant improvement in learner performance, it proved to be at least as effective or equivalent to traditional instruction. Furthermore, results show that CBT lead to improved learning motivation and contributed to a positive attitude towards teaching the COBOL programming language.
Below follows a list of research outputs produced by the author during this study.

<table>
<thead>
<tr>
<th>Output Type</th>
<th>Authors</th>
<th>Title</th>
<th>Institution/Event</th>
<th>Status</th>
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<td>March 2002</td>
</tr>
</tbody>
</table>

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Signature: _______________     Date:  _______________

Prof. M Weideman
# TABLE OF CONTENTS

## CHAPTER 1: INTRODUCTION

1.1 OVERVIEW ................................................................. 1  
1.2 BACKGROUND TO THE RESEARCH PROBLEM .......... 1  
1.3 AIMS AND OBJECTIVES ........................................... 3  
1.4 HYPOTHESES ............................................................ 5  
1.5 DELINEATION OF RESEARCH ..................................... 6  
1.6 SUMMARY ................................................................. 7  

## CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION ............................................................. 8  
2.2 COMPUTERS IN EDUCATION ........................................ 10  
  2.2.1 Computer technology ......................................... 11  
    2.2.1.1 User learning modality matrix ..................... 12  
2.3 CBT ........................................................................ 14  
  2.3.1 Advantages of CBT ............................................. 15  
  2.3.2 Disadvantages of CBT ....................................... 17  
2.4 MULTIMEDIA IN EDUCATION ...................................... 19  
  2.4.1 Advantages of multimedia in CBT ....................... 22  
  2.4.2 Learner motivation ............................................. 23  
  2.4.3 Learner control .................................................. 24  
  2.4.4 Self-paced learning .......................................... 25  
  2.4.5 Active and passive learning ............................... 26  
    2.4.5.1 Active learning ......................................... 26  
    2.4.5.2 Passive learning ....................................... 27  
  2.4.6 Animation ......................................................... 28  
2.5 WBT EDUCATION ....................................................... 30  
  2.5.1 E-learning ......................................................... 33
CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 OVERVIEW .............................................................. 46
3.2 INTRODUCTION ........................................................ 47
3.3 EVALUATION DESIGN ................................................. 49
  3.3.1 Four levels of evaluation ........................................ 49
  3.3.2 Ten stages of software evaluation ............................. 51
  3.3.3 Effectiveness measures ......................................... 53
  3.3.4 Formative and summative evaluation ......................... 54
    3.3.4.1 Formative evaluation .................................... 54
    3.3.4.2 Summative evaluation .................................. 55
3.4 FIELD TRIAL ............................................................. 56
3.5 PARTICIPANTS .......................................................... 58
3.6 PROTOTYPE CBT MODULE ........................................... 59
  3.6.1 Development of prototype CBT module ..................... 60
    3.6.1.1 Animated pedagogical agent ............................... 64
  3.6.2 Prototype process ............................................... 66
  3.6.3 Alpha and beta testing of prototype CBT module ........... 67
  3.6.4 User interface design .......................................... 69
3.7 USABILITY .............................................................. 76
  3.7.1 Factors for perceived usefulness ............................. 79
  3.7.2 Learnability ...................................................... 82
  3.7.3 Consistency ...................................................... 82
3.7.4 Visual design and HCI ................................................. 83
3.7.5 Interactivity .......................................................... 85
3.7.6 The REAL model.................................................... 88
3.8 MACROMEDIA FLASH DEVELOPMENT TOOL .......... 89
3.9 CBT DELIVERY .......................................................... 90
3.9.1 WebCT platform ..................................................... 90
3.10 THE CBT MODULE ................................................... 93
3.11 PRE- AND POST-TESTS .............................................. 103
  3.11.1 Pre- and post-testing procedure ......................... 105
    3.11.1.1 Pre-test .................................................. 106
    3.11.1.2 Post-test ............................................... 107
  3.16.2 Pre- and post-test feedback ................................. 107
3.12 QUESTIONNAIRE .................................................... 108
  3.12.1 Questionnaire procedure .................................... 109
3.13 SUMMARY ............................................................. 110

CHAPTER 4: DATA ANALYSIS, RESULTS AND INTERPRETATION

4.1 INTRODUCTION ......................................................... 111
4.2 DATA ANALYSIS AND RESULTS .................................. 112
  4.2.1 Pre- and post-tests ............................................. 112
  4.2.2 Questionnaire .................................................... 121
    4.2.2.1 Demographic information .............................. 122
    4.2.2.2 Interface and usability of the CBT module...... 128
    4.2.2.3 CBT module content .................................. 136
    4.2.2.4 Learner attitude ........................................ 146
    4.2.2.5 Pre- and post-tests component ..................... 152
    4.2.2.6 Most valuable and least valuable aspects of CBT module ...................... 155
4.3 INTERPRETATION OF RESULTS .................................... 159
4.4 SUMMARY ............................................................. 161
### LIST OF TABLES, FIGURES AND GRAPHS

#### TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>The user learning modality matrix</td>
<td>14</td>
</tr>
<tr>
<td>3-1</td>
<td>Effectiveness measures</td>
<td>53</td>
</tr>
<tr>
<td>3-2</td>
<td>Comparative experimental design</td>
<td>58</td>
</tr>
<tr>
<td>3-3</td>
<td>Methods/techniques of usability testing</td>
<td>81</td>
</tr>
<tr>
<td>4-1</td>
<td>Pre-test and post-test data from summative evaluation (score out of 25)</td>
<td>117</td>
</tr>
<tr>
<td>4-2</td>
<td>Descriptive statistics for control and experimental groups (percentages)</td>
<td>117</td>
</tr>
<tr>
<td>4-3</td>
<td>Comparison of control and experimental group means in the pre- and post-tests</td>
<td>120</td>
</tr>
<tr>
<td>4-4</td>
<td>Six variables created for items within the questionnaire</td>
<td>121</td>
</tr>
<tr>
<td>4-5</td>
<td>Correlation between variables</td>
<td>121</td>
</tr>
<tr>
<td>4-6</td>
<td>CBT module evaluation tabulation on usability and looks of CBT module (Q9 – Q11)</td>
<td>129</td>
</tr>
<tr>
<td>4-7</td>
<td>CBT module evaluation tabulation on usability and looks of CBT module (Q12 – Q14)</td>
<td>130</td>
</tr>
<tr>
<td>4-8</td>
<td>Learners’ positive comments on the general appearance of the CBT module’s interface (Q15)</td>
<td>132</td>
</tr>
<tr>
<td>4-9</td>
<td>Learners’ concerns on the general appearance of the CBT module’s interface (Q15)</td>
<td>133</td>
</tr>
<tr>
<td>4-10</td>
<td>CBT module evaluation tabulation on usability of CBT module (Q16 – Q18)</td>
<td>134</td>
</tr>
<tr>
<td>4-11</td>
<td>CBT module evaluation tabulation on usability and looks of CBT module (Q19 – Q21)</td>
<td>135</td>
</tr>
<tr>
<td>4-12</td>
<td>CBT module evaluation tabulation on content of CBT module (Q22-Q24)</td>
<td>137</td>
</tr>
</tbody>
</table>
Table 4-13: CBT module evaluation tabulation on content of CBT module (Q25-Q26) ........................................................................ 138
Table 4-14: CBT module evaluation tabulation on content of CBT module (Q27-Q28) ................................................................. 139
Table 4-15: CBT module evaluation tabulation on content of CBT module (Q29-Q32) ................................................................. 140
Table 4-16: Positive comments from learners on the content of the CBT module (Q33) ................................................................. 141
Table 4-17: Additional comments from learners on the content of the CBT module (Q33) ................................................................. 142
Table 4-18: Recommendations from learners on possible improvements that can be made to the CBT module (Q34). 143
Table 4-19: Comments on any other aspects of the CBT module that learners have found to work well (Q35) .......................... 145
Table 4-20: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q36, Q38 and Q39) ................. 146
Table 4-21: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q40 – Q42) ............................ 149
Table 4-22: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q43 – Q44) ............................ 150
Table 4-23: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q45 – Q46) ....................... 151
Table 4-24: CBT module evaluation tabulation on results from pre- and post-tests (Q47 – Q49) ....................................................... 152
Table 4-25: CBT module evaluation tabulation on results from pre- and post-tests (Q50 – Q51) ....................................................... 153
Table 4-26: CBT module evaluation tabulation on results from pre- and post-tests (Q52 – Q53) ....................................................... 155
Table 4-27: Comments from learners on what they thought was least valuable about the CBT module (Q54) ......................... 156
Table 4-28: Comments from learners on what they thought was most valuable about the CBT module (Q55) ......................... 157
FIGURES

Figure 3-1: Ten stages to follow when evaluating software and its effects on learning..................................................... 52
Figure 3-2: Module introduction screen for PowerPoint CBT prototype. 61
Figure 3-3: Animated guide used in the PowerPoint CBT prototype...... 65
Figure 3-4: The quit screen......................................................... 97
Figure 3-5: The module introduction screen..................................... 98
Figure 3-6: The module content screen............................................ 99
Figure 3-7: The module objectives screen............................................ 99
Figure 3-8: WebCT main menu with lesson topics.................................. 100
Figure 3-9: The loading screen............................................................. 101
Figure 3-10: The title page screen........................................................ 101
Figure 3-11: Example of a module content screen.......................... 102
Figure 3-12: Example of review question developed in PowerPoint...... 103

GRAPHS

Graph 4-1: Comparison of pre-test percentages between control and experimental groups .................................................. 114
Graph 4-2: Comparison of post-test percentages between control and experimental groups .................................................. 115
Graph 4-3: Comparison of gain percentages between control and experimental groups .................................................. 116
Graph 4-4: Pre-test vs. post-test scores (control group)...................... 118
Graph 4-5: Pre-test vs. post-test scores (experimental group)............. 118
Graph 4-6: Gain score comparison between control and experimental groups .................................................. 119
Graph 4-7: Proportion of males and females who completed the questionnaire (Q2).................................................. 123
Graph 4-8: Proportion of learners enrolled for the FIS and IT programmes (Q1)………………………………………………………… 124
Graph 4-9: Learner age distribution (Q3)……………………………………………… 124
Graph 4-10: Proportional distribution of learners’ language preference (Q4)……………………………………………………………… 125
Graph 4-11: Timeframe for learner computer use (Q5)……………………………………… 126
Graph 4-12: Proportion of learners feeling confident to work with everyday applications (Q6)……………………………………………………… 126
Graph 4-13: Proportion of learners that have a PC at home (Q7)………………………………… 127
Graph 4-14: Proportion of learners that used CBT material in the past (Q8)………………………………………………………………… 127
Graph 4-15: Evaluation results for usability and looks of CBT module (Q9 – Q11)……………………………………………………………… 129
Graph 4-16: Evaluation results for usability and looks of CBT module (Q12 – Q14)………………………………………………………………… 131
Graph 4-17: Evaluation results for usability of CBT module (Q16 – Q18)……………………………………………………………………… 134
Graph 4-18: Evaluation results for usability and looks of CBT module (Q19 – Q21)…………………………………………………………… 136
Graph 4-19: Evaluation results on content of CBT module (Q22 – Q24).……………………………………… 137
Graph 4-20: Evaluation results on content of CBT module (Q25 – Q26).……………………………………… 138
Graph 4-21: Evaluation results on content of CBT module (Q27 – Q28).……………………………………… 139
Graph 4-22: Evaluation results on content of CBT module (Q29 – Q32).……………………………………… 140
Graph 4-23: Evaluation results on learners’ attitude towards the CBT module (Q36, Q38 and Q39).………………………………………………… 147
Graph 4-24: Evaluation results on learners who feel that they achieved the objectives stated in the CBT module (Q37)………………………………………. 148
Graph 4-25: Evaluation results on learners’ attitude towards the CBT module (Q40 – Q42)………………………………………………………………… 149
Graph 4-26: Evaluation results on learners’ attitude towards the CBT module (Q43 – Q44)……………………………………………………………… 150
Graph 4-27: Evaluation results on learners’ attitude towards the CBT module (Q45 – Q46)………………………………………………………… 151
Graph 4-28: Evaluation results on the pre- and post-tests (Q47 – Q49).. 153
Graph 4-29: Evaluation results on the pre- and post-tests (Q50 – Q51).. 154
Graph 4-30: Evaluation results on the pre- and post-tests (Q52 – Q53).. 155
CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

This chapter provides an overview of the thesis content. The research involved a comparative experimental study of two different programme delivery techniques at the Cape Peninsula University of Technology (CPUT) for the Development Software 1 (DOS1) subject. The purpose of the research was to compare traditional learning methods to the use of multimedia in a Computer-Based Training (CBT) module. The chapter starts with a short introduction on the background of the research problem, and outlines the aims and objectives within the ambit of the research. This is followed by the underlying hypotheses and delineation of the research.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

It has become evident that first year DOS1 learners at the CPUT find it difficult to master learning material gleaned from textbooks and lectures only. Poor academic performance is associated with the DOS1 programme with an average failure rate of 40% over a period of three years. Lecturers have become increasingly concerned with the academic performance of learners in the DOS1 programme. Therefore, these lecturers were interested in exploring possible alternatives to traditional classroom-based instruction. DOS1 learners normally attend training in an instructor led, classroom- or laboratory-based training session.
As the functionality of computers increases, it becomes more viable to use CBT as a potential aid to teach subjects such as DOS1. The continuing advancement in computer technology and its use as a training tool, therefore led to the development of a CBT module to deliver learning material to learners. It is internationally recognized that computers can assist in providing interactive learning experiences to learners (Frith, 1997b). Knowledge reflects what the learner has gained from using the CBT module, and can be measured by means of tests, practical activities, assessment etc. (Kirkpatrick, 1975).

Little research has been done in the field of learner performance improvement using CBT material in a programming environment. Available literature in this field of study shows controversial results. Some research returned a significant difference in pre-test and post-test scores between and within the control and experimental groups, while other studies returned an insignificant difference. Controversially, research has also shown that learners who made use of CBT material, performed worse than their counterparts receiving traditional classroom instruction.

In spite of results to the contrary, online multimedia CBT is becoming a preferred additional alternative to traditional classroom-based instruction. It is therefore a requirement to highlight the importance and power of CBT to improve the performance of learners. This research seeks to bridge these gaps by developing and evaluating the effectiveness of an interactive multimedia CBT module. Research was conducted on the effectiveness of CBT on learner performance and attitude. It was necessary to determine if CBT is a viable and effective alternative to the traditional classroom-based instruction. Should the research return positive results, the project has the potential to become a viable alternative to traditional instruction for the DOS1 programme.
The research problem is the poor performance of DOS1 learners, coupled with the lack of an obvious solution in the literature. The research question can thus be formulated as: What is the effect of CBT on learner performance and attitude in the DOS1 subject?

1.3 AIMS AND OBJECTIVES

An analysis of first year DOS1 learner performance confirmed a relatively low pass/success rate. In order to address this problem, while maintaining consistency within the traditional classroom-based instruction, the overall aim of this research was:

- To design and develop an interactive CBT module that can serve as a learning resource to all learners. The aim of the module is to supplement and improve learner understanding of DOS1, and that it would offer some advantages over the more traditional approach of instruction. In support of this objective, Spellman (2000:74) claims that multimedia CBT material offers a more stimulating and motivating learning environment compared to traditional instruction. Riggs, Poli and Woolf (1998) also state that multimedia is better than traditional instruction, because it stimulates various senses. Vroom (1964) relates increased learner motivation to increased learner performance. A high motivational level is often a prerequisite for success. There is a high probability that learning will be without success if there is a lack of motivation (Pichler, 2002).
• To conduct a formal evaluation to determine if the CBT module was an effective teaching aid in terms of its content, interactive features and outcome. According to Gupta (2002:12), course content needs to be interactive and act like a “virtual teacher”. The aim is to compare the traditional learning methods to the use of multimedia in a CBT module.

After CBT instruction, learners who participated should be able to identify different aspects of the programming language. Learners should furthermore be able to design a solution from a given problem and implement it as a fully functional program that reads from an external file and produces a report. An important goal of CBT instruction is that it should be equivalent to or better than the learning provided through traditional face-to-face and classroom-based methods of instruction.

Objectives of the research are to:

• Design and develop an interactive CBT module to enhance first year learner understanding of COBOL programming in DOS1.

• Summatively evaluate the CBT module in terms of its outcome by means of a pre-test vs. post-test approach.

• Formatively evaluate learner attitude and preferences towards the CBT module in terms of its content, interface, usability, and interactive features by means of a questionnaire.
1.4 HYPOTHESES

The research objectives stated in Paragraph 1.3, translate into the following hypotheses:

- The CBT module will be equivalent to or at least as effective as traditional classroom-based instruction as shown by significant differences on statistical tests conducted on pre- and post-test scores.

- Learners will show a positive attitude and preference towards using the CBT module.

Therefore the hypotheses to be tested can be statistically stated:

Null hypothesis ($H_0$): CBT instruction is as effective as traditional instruction.

Alternative hypothesis ($H_1$): CBT instruction is not as effective as traditional instruction.

Null hypothesis ($H_0$): Learners will show a neutral to positive attitude towards CBT instruction.

Alternative hypothesis ($H_1$): Learners will show a neutral to negative attitude towards CBT instruction.
The hypotheses could be tested based on the following data:

- The average performance of the experimental CBT group in the post-test is equal to or better than in the pre-test.

- The average performance improvement of the experimental group is equal to or better than the average performance improvement of the control group.

This author is of the opinion that the CBT module could potentially improve learner academic performance and satisfaction. This manifested as differences on statistical tests conducted on pre- and post-test scores and feedback from the questionnaire.

### 1.5 DELINEATION OF RESEARCH

The participants in this research consisted of first year DOS1 learners at the CPUT. Learners were divided into two groups, namely an experimental group (who made use of an interactive CBT module) and a control group (who attended traditional classroom lecturers). Instruction to the two groups was identical in all respects except the delivery format. All the learners were computer literate, and all have learned the basic concepts of COBOL report programming.

Before the experiment was implemented, all the lecturers involved in the research received both written and verbal instructions about how to conduct the evaluation process. Learners in the CBT group did not receive any direct lecturer instruction during the two-week experiment, but interacted independently with the CBT module.
1.6 SUMMARY

This chapter provided the background to the research problem, and outlined the aims and objectives of the research. Furthermore, the hypotheses and delineation of the research were presented. In Chapter 2, relevant literature will be reviewed in an attempt to find solutions to questions, and to put this research into a theoretical context.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the appropriate literature related to the effectiveness of CBT. It reviews the use of technology in education and the advantages and disadvantages of CBT. Furthermore, the three main research outcomes for this field of study are discussed.

CBT was first mooted in the 1980’s, and although it was entirely text-based and linear, it proved to have the potential of being effective. Hall (1995) found that CBT, whether text-based or multimedia-based, resulted in equal or higher learner performance over traditional instruction. As text-based CBT applications were replaced by multimedia CBT applications (containing graphics, sound, and animation), and computers became more accessible, the success rate and efficacy of computer learning improved. As early as 1989, Barker (1989) found that CBT reduces instruction time, is easier to monitor, and results in better content retention. When the World Wide Web (WWW) was introduced, Web-based training (WBT) was placed onto the Web interface.

Primary research figures that compare multimedia-based training benefits to those of instructor-led training primarily came from industry groups such as Federal Express, IBM and General Motors (Issa, Cox & Killingsworth, 1999:285). Today, many companies view CBT as an effective and efficient training mechanism.
Previous research on the effectiveness of web courses, CD-ROM use, and other CBT methods has shown mixed results (Butzin, 2000; Kaupins, 2002; McKethan & Everhart, 2001). While some studies suggest that CBT can improve learner understanding of academic material, others report that in some instances the use of computers to teach basic skills had no effect on learner academic performance (Chou, 1996; Matthew, 1996). Furthermore, other studies report that CBT is most effective when learners work with CBT material individually or, better in pairs or small groups (Park & Hannafin, 1993; Simpson, 1994). McKethan and Everhart (2001) state that CBT material effectiveness appears to be dependent on its purpose, the context of its use, and the design of the CBT software. Gaytan and Slate (2003:193) cite Pryor\(^1\), who pointed out that several researchers (Kulik & Kulik, 1985; Fletcher & Benson, 1996) found technology-based instruction to be more effective than conventional instruction.

Feenberg (1998) argues that the lack of face-to-face contact makes no difference in achieving successful learning. Furthermore, the quality of online teaching is superior to its face-to-face counterpart. Klett (2001) states that CBT effectiveness focuses on self-controlled learning activities, depends on the accessibility and transparency of information content, and on the learner concerning the personal conditions and recognising ability respectively.

### 2.2 COMPUTERS IN EDUCATION

During the last decade, computers have played an increasingly important role in education. Computers provide an innovative and efficient way for teaching learners (Weiss, Knowlton & Morrison, 2002). In the education field, computerization enables the development of teaching/learning packages. Alessi and Trollip (1991:3) postulate that computers play an important role in instruction alongside the lecturer, the book and other instructional media.

For the purpose of this thesis, learning is contextually defined (e.g. what principles, facts, and concepts were understood and absorbed by the learners?). Hokanson and Hooper (2000), Jonassen, Peck and Wilson (1999), Kulik and Kulik (1991) as well as Neo and Neo (2002:83) state that an individualised, active learning environment can encourage higher learning skills, reduce the time needed for learners to master information, and it can improve knowledge and retention rates. This makes the use of computers in higher education very attractive.

Computers used to assist in teaching, have some advantages over more traditional media. It has the ability to display moving images (animation), and to provide learners with immediate and individual feedback (Frith, 1997d). The computing environment can provide an environment where the learners can work at their own pace, in their own time, and at a location of their choice. Learners now have 24-hour access to online learning material and can be given instant feedback on their performance when completing online learning material or online tests. Good practice supplies prompt feedback (Basson, 2002:15).

2.2.1 Computer technology
Technology is re-shaping the development of educational content and changing the concept of learning. While adequate hardware and software are essential to deliver CBT material, it is “the instructional effectiveness of the courseware that will determine whether CBT can solve a particular education or training problem” (Misselt, 1982:77). According to Tapscott (1998), the more technologically innovative information can be delivered to learners, the better their retention and attention levels will be. A significant constraint affecting the transition into the area of online education is the high cost of the use of advanced multimedia applications or the recreation of classroom lectures (Carr & Thomas, 2000). However, Collins and Berge (1994a, 1994b) provide an alternative approach, whereby the lecturer makes use of the lowest level of technology that will serve the educational purpose and which is widely accessible to learners. This approach may include the use of low cost interactive applications and online environments (Carr & Thomas, 2000).

Technology is improving daily and allows better and faster Internet connections, as well as improved graphics to enrich the content of programmes, which has the potential to significantly improve education. Multimedia technologies can be very effective for many diverse educational situations. However, the inclusion of multimedia alone does not ensure learner success (Kumar, 2005). Cuban (1986) claims that when a technology-centric educational strategy is adopted, it will not necessarily guarantee proper learning goals and processes. Furthermore, technology will not assist in reaching positive learning outcomes unless a learner-centred perspective to teaching and learning is used. It is in fact the designed learning experience that facilitates improved learning outcomes (Robson, 2000:157).

Koohang (1989), Koohang and Durante (2003:107), and Smith and
McNeils (1993) state that the more experience the learner has with the technology, the more he tends to accept it, which in turn can encourage learning. Learners should be able to concentrate on their learning and not spend their time struggling with the technology (Lee, 1996; Sherson, 1999:5). Learning material should furthermore be user-friendly and easy to navigate (Lee, 1996). Factors that can impact upon user acceptance of CBT material include perceived usefulness, perceived ease of use (Davis, 1989:319), computer and software anxiety, attitudes toward computer use, demographic characteristics (e.g. age, gender, educational background) (Igbarria & Parasuraman, 1989), and experience (Taylor & Todd, 1995).

According to Robson (2000:167), learners’ attitude towards study and technology will influence their goals and how they respond to the course content and associated technology. These aspects dictate the areas demarcated for evaluation in this research, namely interface, usability, and aesthetics, to name but a few. Computer technology can lead to an increase in learner performance (Shaba, 2000; Sneddon, Settle & Triggs, 2001:6), as it individualizes the learning process and accommodates individual learner needs, interests, and learning styles (Schacter & Fagnano, 1999). Filipczak (1995), Glennan and Melmed (1996), Kulik (1994) as well as Yeatman and Stace (1997) agree with these findings, and state that computer technology used in the classroom can lead to an increase in learner interest, motivation, attitude and engagement.

### 2.2.1.1 User learning modality matrix

Gaines, Johnson and King (1996) conclude that technology helps move the act of learning from hearing (and forgetting) and seeing (and remembering) to doing (and understanding), which represents a more active way of learning. Of the five sensory modalities three (sight, hearing, and touch) are integral to computer-based learning. Each user relies more on one sensory system than on others to access information. Sime and
Coombs (1993) describe that a communication problem can be prevented by presenting as much information as possible in the sensory system which a learner favours. A user learning modality matrix is presented in Table 2-1. It depicts which type of presentation enhances learner understanding, depending on the learner's dominant sensory-learning modality, and gives examples of presentations media favourable to learning.

Sime and Coombs (1993) further state that for example, predominantly visual users learn most easily when complex information and processes are displayed visually, and that pictorial representation of abstract concepts is essential to their learning and cognitive processes. This means that learners cannot learn what they cannot see. The language and presentation of information have a lasting impact on the acceptance or rejection of a given system.

Fidalgo (1993) points out that most learners absorb messages in the following manner: 10% of what is read, 20% of what is heard, 40% of what is seen, and 80% of what is both heard and seen. Furthermore, Wolfgram (1994) states that people remember 15% of what they hear, 25% of what they see, but remember over 60% of what they interact with. This means that if information is presented by using multimedia features, aural and visual senses will be stimulated, and the learner will become involved in the product experience, culminating in learner information retention (Bagui, 1998; Dix, Finlay, Abowd & Beale, 1993; Gaytan & Slate, 2003:187; Gniisci, Papa & Spedaletti, 1999; Johnson & Nemetz, 1998:255; McKerlie & Preece, 1993; Ramsey, 1996:1; Simpson, 2001:1).

Table 2-1: The user learning modality matrix (Source: Sime and Coombs, 1993)
<table>
<thead>
<tr>
<th>Visual (what you see)</th>
<th>• Interactive visual instrumentation.</th>
<th>N*</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• CBT.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Graphic display of concepts and calculations.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auditory (what you hear)</th>
<th>N</th>
<th>• Voice synthesizers.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• Audio cassettes coordinated with voice instructions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Classroom instruction.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kinesthetic (what you touch/feel)</th>
<th>N</th>
<th>N</th>
<th>• Touch screens.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>• OCR type devices, e.g. mouse.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Interactive keyboard.</td>
<td></td>
</tr>
</tbody>
</table>

*Non-conducive to users’ dominant sensory-learning modality

### 2.3 CBT

Frith (1997b) expresses the opinion that authoring software can enable lecturers to develop CBT materials that can be presented through the use of computers. Currently, authoring software makes animation accessible to any lecturer who is *au fait* with the software (Sturman, 1998). These learning aids are commonly referred to as CBT, CAL (computer-aided learning) and CAI (computer-aided instruction). CBT however refers to any educational tool which is on a computer, and is not necessarily synonymous with the use of multimedia (Simpson, 2001:2).

According to Azarmsa (1991), CBT makes use of computers to present instruction to learners, and to help them learn new material or improve knowledge of materials previously studied. Mehrabi, Glückstein, Benner, Hashemi, Herfarth and Kallinowski (2000:97) postulate that CBT can be used to teach material of a specific field and simultaneously, offer various ways of objectively assessing learner knowledge.

Authoring tools (e.g. Java, HTML editors, Visual Basic, Authorware,
Director, Toolbook, Flash etc.) make it possible to develop teaching material that can be delivered by computer as either a mandatory part of the programme, or as additional training material. This kind of material is referred to as CBT. While it is accepted that CBT material can be used to provide quality education, it cannot necessarily replace lectures, tutorials or practicals (Frith, 1997c). It is of importance to note that in this research, the CBT module is implemented to function as “additional training material”, and not to replace classroom lectures. CBT is often required to be better than traditional methods of teaching in order for it to be considered as an alternative teaching method (Simpson, 2001:7). The analogy can be drawn that a combination of multimedia and traditional instruction would be the ideal approach to follow (Aly, Elen & Willems, 2004; Smith & Woody, 2000:223).

2.3.1 Advantages of CBT

Advantages of delivering learning material in a CBT format on the Internet include:

- Easy delivery (Kilby, 2005).

- Easy updating of information (e.g. bug fixes, version updates, layout improvements, and all maintenance can be done without distributing update versions on CD-ROM or making patches available through the Internet (Brahler et al., 1999; Kilby, 2005; Pichler, 2002:5-17).

- Controllable access (Kilby, 2005; Vivekananda-Schmidt, Hassell & McLean, 2004).

- Availability of additional resources via links (Balasubramanian, 2002:9).
• Progressing at own pace (allows learners to control the learning process e.g. order of presentation, number of repetitions etc.) (Vivekananda-Schmidt et al., 2004) (Paragraphs 2.4.3 and 2.4.4).

• Repetition (learners can repeat learning material as much as they want. It thus allows for learners to receive increased instruction, without increasing lecturers’ contact hours) (Alessi & Trollip, 1991:5; Simpson, 2001:9).

• Self-directed (learners can choose topics for study from example a menu).

• The use of more than one means to present information, thereby accommodating more than one learning preference (Vivekananda-Schmidt et al., 2004).

• Interactivity (Vivekananda-Schmidt et al., 2004) (Paragraph 3.7.5).

• It may be used to teach a specialised subject (Alessi & Trollip, 1991:5; Simpson, 2001:9).

Brown (1997:3) is of the opinion that CBT increases learner access to learning, enhances learning quality, and provides a wider range of learning options. In support of the above, Davies and Crowther (1995) claim that CBT increases student motivation, facilitates active and experiential learning, is consistent with learner-centered learning, and that it leads to better learning. Kulik and Kulik (1991) also state that CBT is an effective method for teaching and learning. Klett (2002:39) adds by saying that “effectively designed learning environments can be used to enhance the motivation on an individual basis".
Kraus and Gramopadhye (2001) list CBT advantages such as adaptability and record keeping. CBT can be done at times convenient to the learner, and it only needs to involve the learner being trained. In contrast with this approach, traditional training requires cautious scheduling of lecturers. Furthermore, record keeping tracks learners’ progress and provides the lecturer with information concerning the learners’ level of understanding.

2.3.2 Disadvantages of CBT

CBT has several disadvantages. Frith (1997e) and Beckstrand (2002:34) point out that good quality CBT is expensive to develop and requires a huge investment in time and expertise. Ramsey (1996) agrees with Frith (1997e) by stating that a multimedia system generally requires a considerably superior level of effort to create, compared to text-based instruction.

Frith (1997e) also mentions that CBT delivery needs expensive computer hardware and that a large number of computers are needed to conduct evaluations on CBT material. Furthermore, online learning material is not always easily accessible by all learners (Lowder & Hagan, 1999). Merrill and Twitchell (1994) found that college learners have years of experience reading textbooks, and may be used to page through books at their own pace when learning. To require learners to engage in activities that disrupt their familiar learning style may frustrate them. It may also interfere with their learning ability compared to learners who were able to simply read the information and proceed without interruption. The learning process also has the potential to become depersonalised. If the lecturer is removed from the teaching process, learners who thrive on personal interaction or who are uncomfortable with computer technology may experience disadvantages using CBT applications (Simpson, 2001).
The challenge for online programmes is to keep up with technology and the changing demands of the learners, and to keep up and ahead of competitors to survive (Basson, 2002:63).

Delivering online content also introduces some disadvantages such as bandwidth limitations that restrict instructional methodologies (GVU, 1998; Kilby, 1999, 2005; Mudge, 1999; Vorvoreanu, 2002). Limited bandwidth means slower performance (Kilby, 2005). It is of importance to know what hardware learners have available for using CBT applications. Without a fast and reliable Internet connection, the use of multimedia applications can become problematic. It is important to try and avoid long download times, because this annoys learners (Nielsen, 2000). Nielsen (2000) suggests that a 15 seconds download time is reasonable. The 15 seconds guideline is known since 1968, and was derived from the basic set of response time values. Nielsen (1995:5) states that a system’s response needs to happen within about ten seconds to keep the learner’s attention. For accessing content on the web, a 15 seconds limit is acceptable. A 15 second access time can be achieved if gratuitous graphics and animations are avoided. This approach will ensure minimum download times, and that learners with less sophisticated equipment can easily access CBT material.

A further limitation of delivering online content is that lecturers using WebCT, do not have enough time and the technical knowledge to develop their programmes with WebCT. This results in that some lecturers will not be interested in adopting WebCT to complement programmes. This leads to the non-utilization of all the advantages that WebCT offers. For this particular reason, it is important to bridge the gap between technology and education, and to empower lecturers with the necessary skills to use the technology in an effective way. This will enable lecturers to create their own multimedia materials and applications (Neo & Neo, 2002:92).
2.4 MULTIMEDIA IN CBT EDUCATION

In the middle of the 1980’s, education experts started speaking about the “virtual classroom”. A virtual classroom according to Hiltz (1994), refers to:

“… a situation in which users spatially and/or temporally distributed are involved in a learning process with the support of a technological system, reducing time and space constraints.”

Multimedia has become widely used in different facets of instruction. It becomes more popular as an effective platform for enhancing the teaching and learning process and changing the fundamental concept of learning (Neo & Neo, 2002:81). The majority of research in the teaching and learning environment has its origin in medical studies. However, a relatively small amount of research documents the effectiveness of multimedia in the teaching and learning of programming languages.

Currently computers are incorporated into the learning process and are seen as an integral delivery component in Information Technology education (Marold, 2002). The use of overheads, slides, and handouts are presentation tools of the past, as they are rapidly being replaced by multimedia (Gerkin, 2004). The term multimedia was originally used by distance learning organizations in order to describe their programmes delivered by means of text, television, radio, telephone etc. (Laurillard, 1993).

Carr (1999:31), Halal and Liebowitz (1994:21), as well as Hofstetter, (1993:22) view multimedia as the technological key to future education, and define it as a combination of technologies to assist the educational process. Furthermore, interactive multimedia combines computer hardware, software, and peripheral equipment to provide a rich mixture of text, colour, graphics, sound, animation, and video (Leven, Schulz, Alle &
Klar, 1995; McKerlie & Preece, 1993; Mehrabi et al., 2000:97; Najjar, 1996). The interactive use of these multimedia components, as well as quizzes can facilitate the learning process (Mehrabí et al., 2000:97) and lead to effective learning (Leven et al., 1995; Patel & Russell, 2001:110).

Multimedia has been incorporated into several facets of instruction over the last few years to provide a new method of teaching (Issa et al., 1999). Multimedia can make interfaces more stimulating, natural, enjoyable and satisfying to use than text-based interfaces (Petersen, 1996), and offers great possibilities for communicating technical information in a clear and concise fashion (Eilers, 2002; Johnson & Nemetz, 1998). Rieber (1990, 1991) concurs with Eilers (2002), by stating that animation can be very helpful in presenting high abstract or dynamic processes.

Visual technologies such as static graphics and animations are beneficial to learners in a number of ways (Blank, Pottenger, Kessler, Roy, Gevry, Heigl, Sahasrabudhe & Wang, 2002b). Multimedia courseware can thus be used as a tool to bridge the educational gap between better- and poorly-prepared learners (Deacon, Walton & Wilson, 1997). Multimedia can improve education and learning environments, and it provides a more “objective and expansive” presentation of knowledge (Woolf & Hall, 1995). According to Najjar (1996), learning appears to occur faster when multimedia instruction is used. Stemler (1997) summarizes several features of multimedia for instructional purposes that proved to be educationally effective, namely screen design, learner control and navigation, use of feedback, learner interactivity, and audio and video elements. Bagui (1998) suggests that learning takes place using multimedia, because of characteristics such as interactivity, flexibility, rich content, motivational effects, immediate feedback, stimulating presentation of the material, and the ability to structure instruction.
Basson (2002:11) states that it is important that learners should do self-study in an online education environment. Within the context of such a dispensation, the lecturer must guide learners through the CBT application, analyse their understanding of the concepts, and act as a mentor in instances where there is lack of clarity. This places the lecturer in a new role of mentor and guide, as opposed to being a traditional lecturer and teacher.

Multimedia provides powerful tools to access, store and publish information and to re-shape the delivery methodology of educational content (Neo & Neo, 2002:80). There is an assumption that multimedia facilitates the learning process (Mehhabi et al., 2000). This has led to an increase in interactive multimedia use in CBT. Multimedia can be effective in dealing with learners’ negative attitude towards learning and dissatisfaction with traditional instruction (Najjar, 1996). Nunes, Dihl, Fraga, Woszezenki, Oliveira, Francisco, Machado, Nogueira and Notargiacomo (2002:55) state that multimedia information can be efficient in the learning process, because it can be remembered long after the event.

The author’s premise is that an interactive multimedia CBT module can help learners understand learning material better. CBT can result in an increase in learner academic performance and satisfaction. CBT can furthermore provide the flexibility from traditional teaching to flexible learner-centred teaching (Deacon, Paxton & Carr, 2000). Gilroy, Long, Rangecroft and Tricker (2001) view learner satisfaction as “the peak” for continued success of online learning. The educational value of using such a CBT module is perceived as an option to complement and not replace traditional classroom-based instruction. According to Tway (1995), multimedia offers an excellent alternative to traditional instruction, and by allowing learners to explore and learn at their own pace, they have the opportunity to learn at their full potential. The analogy can be drawn that,
if multimedia technologies are incorporated into the teaching and learning process, it can have a large impact on our traditional method of delivering educational content (Neo & Neo, 2002:81).

2.4.1 Advantages of multimedia in CBT

Savage and Vogel (1996) argue that multimedia technology brings significant benefits to lecturers such as the:

- Refreshment of programme materials leading to more engaging classroom environments.
- Discovery of more effective ways of communicating information.
- Use of computer simulation and animation.
- Use of new approaches to teaching.
- Challenge of organising and maintaining the multimedia databases.
- Improvement of lecturer/learner interaction etc.

Gaytan and Slate (2003) cite Townsend and Townsend (1992) who also listed several multimedia benefits including the following:

- It provides a sense of ownership to the learner.
- It reaches all ages.
- It encourages and validates self-expression.
- It creates an interactive learning environment.

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Other multimedia benefits mentioned by Beckstrand (2002), Carr (1999:36-37), Gupta (2002:13), Leung (2003:124) as well as Stansfield et al. (2004:178), include flexibility of training in terms of time and location, easy updating and revising of programme content, while learners can study at their own pace. The learner can access multimedia CBT material when and wherever suitable, and furthermore offers the opportunity of on-site and off-site training (Beckstrand, 2002:26-27).

Multimedia courseware also encourages more learners to be responsible for their own learning. These findings suggest that appropriate integration of multimedia into learning material can have a positive effect on learning (Gaytan & Slate, 2003:196). According to Issa et al. (1999:282), an adult learner will increase his capacity to interact with data through multimedia. Furthermore, multimedia can enhance the learning process through the fast conversion of data into information.

### 2.4.2 Learner motivation

Over time research has shown that learners learn more from multi-modal products (Najjar, 1996). Lee (1999:20) states that multimedia software may use some or all of the components mentioned by Leven et al. (1995), Mc Kerlie and Preece (1993), Mehrabi et al. (2000), and Najjar (1996) in Paragraph 2.4. Farmer (1995), Lee, Gillan and Harrison (1996a), Poobrasert (2002) as well as Riddle (1995) claim that these multimedia components can motivate learners, and increase their satisfaction and attention processes. The proper use of multimedia components may encourage attention, interest and commitment, however, careless use of these media can reduce the effectiveness of the product. It can even turn learners away (Pham, 1998).
Ramsey (1996:5) argues that it is important to use multimedia components only when it is necessary and appropriate e.g. when it can better present information, instead of simply using media to showcase its technological capabilities. Multimedia “hooks” learners through the use of sight, sound, and response (Farmer, 1995). Randel, Morris, Wetzel and Whitehill (1992) suggest that the more interesting learning material is to learners, the more motivated they will be to learn. Motivation in turn can have an effect on learning outcomes (Ramsey, 1996:25). As mentioned in Paragraph 1.3, Vroom (1964) claims that an increase in learner motivation can lead to an increase in learner performance. Learners more often than not need additional motivation to maintain interest in a task. Interactivity and engaging graphics can assist to provide such motivation (Brick, D’Arbon & Robson, 1998).

### 2.4.3 Learner control

Multimedia instruction promotes learner control over learning and interest in the subject matter (Van Dusen, 1998). Control over the learning process can increase learner motivation to learn (Becker and Dwyer, 1994). A major advantage of interactive multimedia applications is the degree with which the learner can control the application (Gaytan and Slate, 2003:187; Marmolin, 1991; Ramsey, 1996:5) e.g. the learner can control the sequence of presentation of the learning material by interacting with the computer.

According to Nielsen and Tahir (2001), one of the oldest guidelines for usable interaction design is to increase learner control and freedom. Furthermore, it “feels good” to be in control and it “feels bad to be dominated by a machine”. Control over the learning process is a feature that can make CBT more individualistic (Ramsey, 1996). Learners have the ability to make choices about the order of information presentation, and the number of module content iterations. This makes the learning
process more self-directed (Frith, 1997b; Jeffries, Wool & Linde, 2003; Kennedy, Petrovic & Keppell, 1998:408) and creates a greater desire to learn, which in turn can facilitate an increase in knowledge retention.

Multimedia CBT enhances learning by allowing learners full control over content, time, place, and pace of instruction (Cybulskik & Lindin, 2000:9; Downes, 1998; Lowe, Wright & Bearn, 2001; Marold, 2002:117-118; Rosenkrans, 2001; Sherson, 1996). Control over the learning process enables a learner to take a more active role in building a knowledge base (Vivekananda-Schmidt et al., 2004:44). Control over the learning pace enables learners to set their own pace of learning without being held back by slower students or vice-versa (Evans & Fan, 2002; Najjar, 1996).

Furthermore, learners can absorb information at their own pace (Paragraph 2.4.4) and can repeat the questions ad hoc. This type of information presentation emphasises interactivity, which Schwier and Misanchuk’s (1993:5) term, “intentionally designed to teach characteristics, and you get instructional multimedia”.

2.4.4 Self-paced learning

According to Issa et al. (1999:284-285), multimedia-based instruction can be advantageous to self-paced learning, because it can provide immediate feedback to the learner. This ensures that problem areas are identified immediately and that the learner can repeat sections without waiting for someone else to first identify a problem. Self-paced learning enables the learner to spend more time on content, which is not yet fully understood, or to spend less time on sections with which the learner is au fait (McGee, Neill, Goldman & Casey, 1998). This enables a learner to use learning time more efficiently.
2.4.5  Active and passive learning

2.4.5.1  Active learning

Unlike television, radio and video, interactive multimedia allows the viewer/listener to play an active role in the experience (Woolf & Hall, 1995). Hiltz (1994) suggests that the use of an interactive multimedia system promotes the active participation of learners, which in turn results in a positive effect on learner satisfaction. Learning is not successful unless the learner is actively involved in the process (Marold, 2002:117-118). By empowering learners to become involved in their own learning process, interactive applications can improve the quality of training and education by providing easy access to information, and the ability to illustrate ideas in new, innovative ways (Gul, Wan & Darzi, 1999).

Brooks (1997:14) notes that interaction implies that active learning will be encouraged. Despite how important satisfaction levels may be, there are no guarantee that the knowledge and/or skills that the application was designed to teach have actually been learnt (Kirkpatrick, 1975). It is suggested that, compared to traditional classroom-based instruction, those using multimedia are preferred by learners and results in slight but statistically significant improvements in learning (Kulik & Kulik, 1987).

“Learner-centered” does not necessarily constitute “lecturer-absent”, as the lecturer needs to be a facilitator. The lecturer may play a less prominent role, but is not less active in collaborative activities (Hartley & Collins-Brown, 1999:18). The lecturer is thus seen as a person that facilitates learning, guides, and supports learners’ own construction of knowledge (Orlich, Harder, Callahan & Gibson, 1998). This learner-centric learning mode ensures that learners can engage in learning in their own time (Neo & Neo, 2002:84).
2.4.5.2 Passive learning

Traditional instruction refers to learning that relies on a textbook and classroom lectures for knowledge transfer. The learner plays a passive role under this format (Basson, 2002:64; Cybulskik & Linden, 2000; Orlich et al., 1998; Ramsey, 1996:4). Keeler and Anson (1995) state that as a result of passive learning, learners absorb only about 30% of the information presented in lectures. Basson (2002:64) refers to traditional learning, as a learning process where learners receive all the general information and the syllabus beforehand in booklet form and other paper formats. Learners also receive their textbooks beforehand, while any other reading material/lecture notes are received during the duration of the programme. Learners attend classroom lectures, to which they passively listen. Learners can also interact in the classroom once the lecturer has finished the lecture. They receive assignments with certain deadline dates and a final evaluation in some form or another (Basson, 2002:64).

Orlich et al. (1998) explain that in the traditional teaching approach, the lecturer controls the instructional process. The lecturer delivers the content and learners passively listen to the lecture. Learners as a rule play a small part in the learning process (Neo & Neo, 2002:83). Some instructional experts suggest that a lecture format is not as effective as other formats due to the passive involvement of the learner (Shakarian, 1995). Stansfield et al. (2004:175) state that the learner has to play a less passive role and more of an active role in the learning process.

Beller (2002) lists the following limitations of traditional learning:

- Studying at high quality universities is expensive.
- Traditional learning is restricted to a “classroom” at a specific time and place.
2.4.6 Animation

Graphics is defined as any visual representation of an object, concept or process. Animation in turn refers to the use of a series of graphics that change over time and/or space (ChanLin, 2001). Park and Hannafin (1993) use the terms “static visual display” and “dynamic visual display” to distinguish between the presentation forms “graphics” and “animation”. Research provides substantive evidence that supports the argument that learning is positively affected by presenting text with graphics (Glenberg & Langston, 1992; Mayer & Sims, 1994). Animation offers the power to present visual information to enhance learning (Baek & Layne, 1998; Rieber, 1990, 1994). Rieber (1990) and Wilson (1993) add that, animation can also be used to gain learner attention, and to gain that learner attention at the beginning of a lesson.

An advantage of animation is that if it has enough “wow”, learners would actually watch it, and in the process, learn key concepts that will enable them with troubleshooting tasks (Eilers, 2002). Animation makes it possible to present models, which would otherwise be very difficult to visualise from static images only. Klett (2002:39) defines visualization as the “visual representation of data, objects, and systems in order to enhance communication and thus understanding”. The author of this research further states that visual representation can improve the learning competence of diverse learners. Animation can also be used to identify very slow or very fast processes by changing their rate (Alessi & Trollip, 1991:5).
Animation can assist in cutting through the complexity of an interface (Ficarra, 1996). Ficarra (1996) points out that multimedia animation can:

- Represent complicated sequences of steps and can improve situations more realistically and convincingly than textual explanations.
- Maintain user interest by navigating and promoting their advancement in topics.
- Increase the sensation that the user is making considerable progress (gaining time).

Research has returned conflicting results in the use of animation in CBT material. Some experimental studies found no significant effect when using animation (Alesandrini, 1984; Baek & Layne, 1988; Rieber, Boyce & Assad, 1990), whereas other studies have proved the converse (Caraballo, 1985; Rieber, 1990; Rieber & Hannafin, 1988). It is of importance to note that additional media should only be used if they make a significant and relevant contribution in the transmission of information (Johnson & Nemetz, 1998). Should the goal be to draw the learner’s attention to a specific piece of information, then an animated headline can be used (Nielsen, 1995:3). Furthermore, animated text should never be drawn by continuous animation, because moving text is much more difficult to read than static text. Nielsen (1995:3) states that the learner should be drawn to the animation and then be left alone to read the text without any further distraction.
Lecturers continuously look for instructional methods that can contextualise learning, motivate learners, individualise instruction, and increase learner performance. There is a steady and dramatic increase in the use of the Web to deliver instruction material (Brahler, Peterson & Johnson, 1999). WBT is becoming more popular and convenient in higher education (Gunnarsson, 2001).

The creation of WBT can enable learners to access their programme material from anywhere in the world while being engaged in self-directed learning activities (Arnold, 1997; Scheider, 2003:77). This type of training enables learners from a variety of educational backgrounds, with different learning styles and time constraints, to undertake self-directed learning (Ramsden, 1996). Learners have different learning styles and respond differently to various learning activities, calling for learning material to be provided in a variety of formats.

According to Basson (2002:65), the web-based learning process still makes use of classroom lectures. This enables the lecturer to make all the general information, the syllabus and programme outline available on the Web for learners, to access where and when it is required. The Web allows “education to go to the learner” rather than “the learner to his education” (Sherson, 2000:5). Within the context of such a dispensation, learners make use of their textbooks, and any additional learning material is made available online. Basson (2002:65) states that, “the lecturer becomes a mentor who receives continual feedback on learners’ progress and adjusts his classroom sessions correspondingly”.

2.5 WBT EDUCATION
Basson (2002:63) concludes in her study that a combination of WBT and instructor-based training (IBT) programmes are better than doing something in a complete virtual classroom. Basson (2002) is of the opinion that there is less interaction between the learners and the lecturer in the traditional classroom than there is in the virtual classroom.

The Internet has brought added benefits to CBT, such as 24-hour availability, better interactions between learners and lecturers, and furthermore serves as an after-hour teaching assistant to traditional lectures (Tao, Guo & Lu, 2005). Multimedia programmes delivered on the Internet allow increased learner control (Fletcher & Benson, 1996; Soboleva & Tronenko, 2002:492) and have the potential to enhance the learning experience (Gupta, 2002:12). Basson (2002) claims that the Internet is the super highway to education, and that it will dramatically change the course of education during the next few years. The widespread acceptance of the Internet and the use of the WWW or Web technology in tertiary institutions can be viewed as an indication of a paradigm shift in teaching and learning. The electronic format of the Web enables the development of interesting multimedia resources. Content on the Internet or Web are centralized and remotely accessible. This means that the most recent information will be available to the learner, which can be updated or changed easily (Ibrahim & Franklin, 1995).

Other advantages of delivering CBT material on the Web as opposed to paper includes interactivity, the immediacy of graphics and moving images, immediate navigation and searchability (Vogel & Wood, 2002:215). These features are not possible with paper-based instruction delivery (Boroni, Goosey, Grinder & Ross, 1998). Traditional paper-based information e.g. programme information, lecture notes, exercises etc. are now placed on the Web. Currently, lecturers have the choice to provide learners with resources in paper-based format, electronic format, or both (Debreceny & Ellis, 1997).
While the focus of this research is on CBT instruction, the reviewed literature is not limited to only those sources that present guidelines for the design of multimedia CBT material. A significant number of sources present research-based guidelines for the creation of Web-based instruction and the design of Web pages. Lemay (1995), author of *Teach Yourself Web Publishing with HTML in a Week*, provides several guidelines for Web publishing. Lemay (1995) states that creating content for Web pages is no different than writing for traditional text publications. Whether any of the two publication methods are used, it is important to be concise and clear, and to use headers and lists to make it easier to find information. The use of a consistent layout and design are recommended in order to assist the learner to easily navigate through online learning material. According to Klett (2001), the layout considerations should ensure unity and harmony across the presentation of the learning system.

According to several researchers, tertiary institutions can successfully and independently develop WWW based courses by following a number of guidelines. These guidelines include:

- **Presentation:** The content material should support a variety of sensory experiences using interactivity and multimedia elements (Bates, 1993).

- **Evaluation:** Checkpoints and testing are important from the point of view of repetition and learner retention (Maurer, 1997). It is important to evaluate learner performance frequently (Wade and Power, 1998:244).

- **Motivation:** Educational software should motivate learners (Underwood & Underwood, 1990).
• Interface: A well-designed interface will enable learners to interact with the content material without the complex intermediaries, and will aid in the understanding of the knowledge domain and structure (Hedberg & Metros, 1997).

• Web-based programmes: WWW-based educational programmes must be integrated within a well-understood and clearly specified curriculum e.g. clear objectives, content description, method of teaching, student learning, learner assessment and programme evaluation (Wade and Power, 1998:244).

2.5.1 E-learning

Stubbs and Burnham (1990) define electronic learning as:

“... any learning situation where methods and techniques enabled by electronic devices combined with instructors and learners who are physically separated and who use methods and techniques enabled by electronic devices to transmit instructional messages over the distance between them.”

E-learning includes any means of delivering learning materials via the WWW (Whittington, 2000). E-learning is associated with better and more efficient learning outcomes (Kumar, 2005). Redmon and Salopek (2000:38) state that the interactivity of the e-learning experience assists learners to visualize the information and assign it importance. E-learning can also result in an increase in the academic success rate of learners (Smit & Du Plessis, s.a.). Learners receive course content via the Web, and as a result play an active role in the learning process (Leung, 2003:123-124).
2.6 PREVIOUS RESEARCH INDICATING POSITIVE DIFFERENCES

There is frequent debate whether online CBT is equivalent in nature and engagement to traditional teaching and learning (e.g. learner performance) or whether it discourages learners and isolates them from interaction (O’Donoghue, Singh & Green, 2004:64). Numerous studies have been undertaken to analyse and evaluate the efficiency of CBT material. According to Benigno and Trentin (2000:260), and Hannafin and Peck (1988:8), the key element in online programmes is learner interaction.

Several research studies have been conducted in South Africa by a number of universities and educational institutions on the subject of online programmes. The University of Pretoria and Pretoria Technikon are amongst those that make use of the WebCT course management system. The University of the Western Cape has developed its own online software called KEWL (Knowledge Environment for Web-based Learning). Keats (2001) identified several advantages of using the KEWL online system for implementing online programmes. According to Keats (2001), online learning culminates in a competitive advantage due to the following reasons:

- Time for knowledge transfer is quicker.
- Cost savings for travel costs (learners do not need to travel to campus).
- Increased productivity.
- Delivery of quality information, reaching anyone, anywhere, anytime.
- Interaction with experts becomes a reality.
- Learners keep up with global trends.
In recent years, researchers have proved that CBT can match or even outperform IBT. In a study conducted by Harrington and Walker (2001, 2003a, 2003b), CBT groups tended to outperform IBT groups. Findings by Walker and Harrington (2004:301) show that both methods of instruction are effective in increasing test scores from pre- to post-test. Dykman (1994) noted that the Hudson Institute found CBT to have produced an increase in learning and time savings by 30% and 40% respectively. In addition, Ayersman (1996), Boyd (1997), Chu and Chen (2000), Hornung, Lennon, Garrett, DeVellis, Weinberg and Strecher (2000), Kim and Lee (2000) as well as Sutton (2004), found that CBT is an effective method of teaching. Brace-Govan and Clulow (2001) conducted a study comparing traditional learning with online learning, from a learner perspective. Results proved that learners tend to have a positive attitude toward online learning. Learners are also enthusiastic about the amount of flexibility offered by online learning. Evans and Fan (2002) also state that online learning can enhance the learning process and help explain complex events to learners using multimedia.

Results by Forman cited by Issa et al. (1999:285), show that the learning gains of employees who received multimedia instruction were 50% - 60% higher than their counterparts who received traditional instruction. In an earlier study by Kulik, Kulik and Cohen (1980), it was revealed that CBT increased the average examination score of learners with 3%. The use of CBT also significantly reduced time required to teach the subject matter. Cohen and Dacanay (1992) investigated the use of CBT in educating health professionals and found that CBT lead to higher average examination results. Carr and Thomas (2000) as well as Carr (2002) found similar results and suggest that this does not necessarily prove anything about online learning benefits, but it may suggest that studying online did no harm to the learners.

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Adams (1992) has shown that learners that use interactive web delivered multimedia had a 55% learning gain over learners receiving traditional classroom instruction. Research by Scheider (2003:77) indicated a positive trend towards increasing learner performance within a Web-enabled computer technology class. Research by Cho and Park (1998) concluded that nursing students using a web-based application showed significantly better scores and a positive attitude towards the application. Furthermore, Jung, Keel and Irons (1998) proved that the use of a website as part of their classes increased learner satisfaction even though it was not mandatory for learners to use it. Dominguez and Ridley (1999) found similar results when they compared the effect of Web programmes with that of traditional training.

In a series of surveys published in Technology and Student Success (2002), the majority of more than 2000 North American educators indicated that Web-based teaching tools are as important as traditional teaching aids. They also determined that learner performance improves by Web-based learning activities, and that learners perceived Web-based learning material to be more effective learning aids than traditional resources (Hashiba, Inagawa, Matsuto, Motonaga, Yamakawa & Akazawa, 2000).

Learners using multimedia instruction in Education Psychology produced an improved knowledge base as opposed to learners who received classroom-based instruction (Delclos & Hartman, 1993). Research carried out by Stoner and Harvey (1999) at the University of Glasgow returned that learner performance improved significantly over the period they made use of a CBT package.
A study by Mehrabi et al. (2000:105) found that the CBT group performed 15 – 20% better than the lecture group. Furthermore, 100% of the learners found CBT to be useful in learning. Petitt (1994) also found that a standard multimedia system resulted in significantly higher scores than a text-based method. Similar results were found by Roesch, Gruber, Hawelka, Hamm, Arnold, Popal, Segerer, Landthaler and Stolz (2003) as well as Scheines, Leinhardt, Smith and Cho (s.a.). Research by Apostolos, Panagiotis, Athanasios and Konstantinos (2005:61) has shown a significant increase in post-test results for the multimedia CBT group when compared to the traditional group.

Neethling (2000) conducted a study to determine whether learners are ready for online programmes. Neethling (2000) has found that 97% of a sample is prepared to make use of online programmes if it is offered in conjunction with traditional programmes. Furthermore, results showed that although acceptance of online programmes is slow, more learners and lecturers realise the benefits of online programme material and online resources. The sample indicated as to what type of material learners would accept online. It included general course information, general communication and course notes. The type of material learners did not want to see online was examinations, tests and lectures. Acceptability of online programmes according to each faculty was ranked as follows: Law (81%), Commerce (70%), Humanities (58%), Sciences (55%), Engineering (50%) and Health Sciences (22%). Neethling (2000) concluded that the differences resulted from some programmes being more theoretical (e.g. Law and Commerce) and others more practical (e.g. Health Sciences). Programmes which were more theoretically oriented were considered more suited to online environments than those that were more practically oriented.
Deacon et al. (2000) conducted a study at the University of Cape Town to investigate how computer-based information technology could be utilised to support fourth year B.Comm. learners. An integrated project-based learning environment was created for a multidisciplinary commerce programme by customizing the Microsoft Office suite. As in the instance of previous studies on the same subject, this study produced positive results and indicated that computer-based tutorials have the potential to make significant contributions to the fourth year B.Comm. programme.

A study of a first year human anatomy course in the biomedical sciences, found that learners who made use of CBT before performing dissections, improved the quality of their learning (Gunn & Maxwell, 1996). As early as 1987, a study by Escanero and Aldo (1987) found that integrated multimedia in a CBT biochemistry programme enabled learners to perform at a higher level. Chang (2000) and Hofstetter (1992) report similar results in that learners showed a higher interest and motivation in multimedia programmes.

McConnell and Schoenfeld-Tacher (2001) revealed that learners who made use of online programmes outperformed their counterparts in content tests. Desai, Richards and Eddy (2000), and Engum, Jeffries and Fisher (2003:71) found similar results that indicate that CBT is more effective than IBT.

After using CBT, post-test scores (95%) for food services workers at a hospital, improved significantly from the pre-test (74.5%). The CBT also had a positive impact on a wide range of workers (Eckerman, Abrahamson, Ammerman, Fercho, Rohlman & Anger, 2004:317). By using a computer supported learning system (CECIL) at the University of Auckland’s School of Biological Science, Gardner, Sheridan and White (2002:133) proved that Biological Science learners both recognize the learning system to be useful and gained advantage with their studies.
Soboleva and Tronenko (2002:483) concluded in their research that CBT learners achieved a higher level of language competence and highly rated CBT’s motivating and educational value. Felix (1998:55) reported that while not all learners are in favour of technology, the majority find it enjoyable and useful to work with good multimedia materials. Research by Wang and Munro (2004:539) confirm the results of Soboleva and Tronenko (2002), by stating that CBT can be effective in improving second language learner perceptions and productions of segmental speech contrasts.

In a report on the acceptability of a CBT package on orthodontics to undergraduates compared to traditional teaching methods (Stephens & Dowell, 1983), 30% of the learners preferred using the computer, 45% preferred to discuss the problem with a lecturer, and 14% indicated no preference. Stephens and Dowell (1983) concluded that CBT was significantly more popular than private study, but significantly less popular than small-group instruction.

Sherry (1996) has proved that learner preference for a certain learning style is an important variable in learning effectiveness. What may be suitable for one type of learner may not necessarily work for another. According to Canfield (1992), learning style refers to the moving component of educational experience that motivates learners to perform. According to Dunn, Beaudry and Klavas (1989), if learning preferences are supported through altering educational conditions to meet learning style preferences, statistically significant improvements in behaviours, grades, and attitudes will be observed.

Even earlier research conducted by Kulik, Bangert and Williams (1983), revealed that CBT methods tend to raise the mathematics performance of learners. It also proved that CBT methods encouraged a positive attitude toward mathematics. Funkhouser (2003:163) reports similar results on the
effect of CBT software on mathematics performance and attitudes toward mathematics of secondary school learners. Callon\textsuperscript{4} as cited in Gaytan and Slate (2003:194-195) used multimedia in college math classes during a pilot project. Callon found that the use of computer technology enabled learners to better grasp fundamental concepts than those taught under traditional formats. Furthermore, the use of multimedia led to improved learner attitudes towards learning.

2.7 PREVIOUS RESEARCH INDICATING INSIGNIFICANT DIFFERENCES

Despite many studies suggesting that multimedia CBT benefits learners, there are also studies that proved no significant differences between the CBT group and the traditional classroom-based group (Adams, Kandt, Throgmartin & Waldrop, 1991; Lee \textit{et al.}, 1996b; Merchant, Kreie & Cronan, 2001; Skinsley & Brodie, 1990). Researchers have found that traditional education was as good as or even better than CBT (Basson, 2002; Carey, 2001; Morrell, 1992). Tucker (2001) states that the most suitable method for learning is based on an individual’s learning style. As with previous research, Jeffries \textit{et al.} (2003:73), Kulik and Kulik (1991) and Tao \textit{et al.} (2005) also found that the use of interactive multimedia results in knowledge gains, even though there were no significant outcome differences between the two groups. Balasubramanian (2002:50), Dewhurst and Williams (1998), Holt, Miklaszewicz, Cranston, Russell-Jones, Rees and Sönksen (2001:539) as well as Buzzell, Chamberlain and Pintauro (2002) found similar results in their study. The difference between the pre- and post-test scores indicated no statistical difference in knowledge gain between the CBT and traditional groups. This finding suggests that learners can be taught as effectively with multimedia as with traditional lectures. According to Beckstrand (2002:12), Fitzgerald and

Koury (1996), Hiltz, Coppola, Rotter, Turoff and Benbunan-Fich (1999), Kinney (2001), Russell (1999), Russell, Durling and Griffiths (1999), and Waschull (2001), comparisons of CBT with conventional instruction, proved that CBT is at least as effective as conventional instruction. This suggests that CBT is not worse than the conventional approach.

Research by Louw (2003) returned that first year mathematics students at the University of Stellenbosch in the experimental group (CBT) did not perform significantly better than the control group (classroom-based). Carr (2002) found that learners from disadvantaged backgrounds performed worse when using CBT, than learners in the classroom.

Aly et al. (2004:43) conducted a study on 26 final-year dental learners. Learners used either an interactive multimedia courseware package (n = 15) or attended traditional lectures (n = 11) on equivalent material. Results proved that the pre- and post-test assessments showed no significant difference between the two groups. Both groups have shown an improvement in their scores, however there was no significant difference between the two groups after receiving different types of instruction. The interactive multimedia courseware package was found to be at least as effective as the traditional lecture for undergraduate training in orthodontics. Research by Bissell, McKerlie, Kinane and McHugh (2003) proved that CBT undergraduate dental learners performed equally effective as their traditional classroom counterparts in teaching periodontal pocket charting.

Gunnarsson (2001) also found that online graduate level statistics learners achieved more or less the same results as learners in a traditional classroom setting. One of the major challenges of online learning is to change the mindset of learners as well as that of lecturers (Basson, 2002:22). Research conducted by O’Malley (1999) for business students, found that learners had the perception that their grades would not differ
significantly whether they did the programme in a classroom, online or via distance learning. The learners were of the opinion that they would prefer to receive their lectures in a classroom, but that an online programme would allow for several advantages e.g. saving time and fitting more readily into their schedules. They regarded distance learning negatively, and did not recognize distance learning to be an improvement over traditional learning.

Studies by Kulik and Kulik (1991) and Simpson (2001) have shown that carefully focused CBT can be at least as effective as traditional teaching methods for appropriately chosen subjects. A study by Chu and Chen (2000) indicate that the positive effects of CBT are more evident in learning academic-related content. Wiebe and Martin (1994) as well as Cockerton and Shimell (1997) argue that there is no difference between computer-based activities and more traditional classroom activities in improving learners’ learning performance. Velan (2002) argues that multimedia CBT materials, which are used purely as add-ons or optional extras to existing programme materials and assessment methods, may have little or no positive impact on the quality of teaching and learning. Velan (2002) also states that it is important to ensure that CBT materials are not just a transcribed textbook reformatted for electronic delivery.

Stasko, Badre and Lewis (1993) performed an empirical study of learning algorithms using algorithm animations. Their study examined learning performance about the algorithm using text only (control group) and text plus animation (experimental group). The experimental group scored slightly higher marks, but the difference proved to be statistically insignificant. Studies conducted by Chang (2001:263), Kraus and Gramopadhye (2001:141), Lowe et al. (2001), Marold, Larsen and Moreno (2000) as well as Poobrasert (2002) also indicate that CBT is as effective as traditional IBT.
Kulik and Kulik (1985) conducted a research analysis of 199 studies involving instruction and test scores in high schools, institutions of higher learning and adult education studies. Results indicated that CBT increased reported test scores by 0.31 standard deviations. Furthermore, although the majority of research supports the use of CBT as a supplementary tool to traditional classroom-based instruction, its effectiveness, as an independent instruction tool is inconclusive.

Snyder (1994) and Poobrasert (2002) also believe that computers cannot (or will ever) replace lecturers, but that it should be used by lecturers as an additional useful tool to enhance instruction. McAlpin (1998) found that the delivery method did not prove to be a factor in the final academic performance of the learners, while Clarke (1999) found no significant differences in test scores amongst the learners in their research.

2.8 PREVIOUS RESEARCH INDICATING NEGATIVE DIFFERENCES

Although a relatively large amount of research reports no significant difference in learning outcomes between delivery modes, much shows that CBT learners fared marginally worse (Brown and Liedholm, 2002).

An investigation by Hobson, Carter, Hall and Atkins (1998) found that orthodontic traditional learners scored better results than the CBT learners did. Other research also found that instructor-led learners tended to achieve higher scores than the technology-led learners in measures of the amount learned and its popularity (Keyes, 1990; Maul & Spotts, 1993). In a study by Steele, Palenskry, Lynch, Lacy and Duffy (2002), the majority of participants indicated a preference for lecture- and text-based learning over CBT instruction.
Hobson et al. (1998) investigated CBT compared to a tutorial on orthodontic assessment and treatment planning. The results proved that learners who attended traditional lecturers, indicated a significantly greater gain than those taught by CBT. LaBonty (1989), Morrell (1992), as well as Ruef and Layne (1990) have also shown unfavourable results when CBT was used as a sole instructional method when compared to traditional classroom-based instruction.

2.9 INSTRUCTION IN PROGRAMMING LANGUAGES

As referred to in Paragraph 1.2, a relatively small amount of research has been conducted in the use of CBT material in a programming environment. Only four articles on CBT in teaching programming languages were found.

An experimental evaluation conducted by Blank et al. (2002b) in an undergraduate Programming Languages class revealed that learners, who used a multimedia tutorial, achieved a significantly greater precision in detecting emerging trends, than their counterparts who received traditional classroom-based instruction. Blank et al. (2002b) found similar results for a course entitled Introduction to Computing. There was a difference in scores (pre-test vs. post-test) between the CBT and traditional groups, however, the difference was insignificant.

Research by Dagdilelis, Evangelidis, Satratzemi, Efopoulos and Zagouras (2003:322) shows that learners were eager to use a CBT module in a X-Compiler programming class. The majority of the learners indicated that they would prefer having the module as part of the educational curriculum.

Second year learners in a C++ programming course at the University of Dundee, found the CBT material to be a valuable and motivating learning medium. Learners felt that the material filled information detail which was missing from textbooks. Furthermore, learners appreciated that they could
learn in their own time and at their own pace. Learners agreed that the animated demonstrations were the strongest motivating factor of the CBT material. However, learners indicated that they did not learn more using the material but that it greatly aided retention (Rowe & Gregor, 1999:68).

2.10 SUMMARY

Online multimedia CBT instruction is a growing and continually changing type of instruction. After reviewing the advantages and disadvantages of multimedia CBT instruction, it has become clear that when CBT modules are developed, one must be aware of the many guidelines expressed in the research that have been cited. Furthermore, the three main different research outcomes for this field of study were briefly discussed, namely research results that indicate positive differences (CBT learners perform better than learners that receive IBT), insignificant differences (CBT learners perform equivalent to, or at least as good as learners receiving IBT) and negative differences (CBT learners perform worse than their counterparts receiving IBT).
CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 OVERVIEW

In this chapter the author discusses the research methodology selected to examine the research problem, and includes a description on the participants, research design and instrumentation.

This chapter deals with the design and development of an interactive CBT module used in this research. The ten key elements that lead to effectiveness in the design, development, implementation, and maintenance of successful CBT modules are discussed. This chapter commences with a discussion of the design philosophy and the delivery methods that were employed. The various software products used in this research are described, and the use of these tools to create the CBT module is then outlined. The chapter is concluded with a discussion on the evaluation measures applied. The literature study in Chapter 2 forms the framework for the empirical study in this chapter. The key elements of effective CBT that were identified in Chapter 2 are used to investigate learner perceptions of CBT in the DOS1 subject. Furthermore, this chapter provides a description of the research design, the sampling strategy, the type of data that was collected, the design of the instruments used to collect the data, and the data analysis methods used. The results of the data processing and the interpretation thereof are outlined in Chapter 4.
3.2 INTRODUCTION

All teaching innovations must be evaluated to validate academic standards and benefits. It is of extreme importance that the CBT module must be evaluated to extend the module’s success. According to Balasubramanian (2002:50), an online module should produce similar (or better) results than an equivalent traditional class. If the outcomes proved not to be better, future developments and modification might be needed. Evaluation is important, because there is always the concern of impacting upon learners by following a trend that may or may not have any pedagogical value. Evaluation is critical to success. In order to illustrate academic standards for online programmes, objective data such as test results and subjective data such as learner preference must be collected (McConnell & Schoenfeld-Tacher, 2001).

It is generally believed that evaluation appears to be one of the most neglected facts of instructional design and development processes. As a rule, CBT evaluation is primarily concerned with three aspects namely, to determine how well CBT applications can be deployed within a particular curriculum, whether objectives have been achieved, and whether CBT have performed well in comparison with other training methods (Pham, 1998). Jacobs (1998) defines evaluation as a systematic review process of the value and effectiveness of courseware. Venter, Blignaut and Stoltz (2001) explain that the evaluation of the performance of a system can be measured by its “efficacy”, “efficiency” and “effectiveness”. Efficacy tests whether the chosen approach produces the required output. Efficiency tests if the method is economical on resources, whereas effectiveness tests whether the procedure will withstand the passage of time and satisfy long-term aims.
The purpose of evaluation in this research was to determine whether CBT would be effective in teaching first year DOS1 learners, and to ascertain its effects on learner performance as well as learner satisfaction. When the evaluation process is planned, the purpose, interests of those involved, and the practical limitations must be considered (Harvey, 1998:9; Whalen, 1998). Evaluation is mainly used to assess (and improve) the effectiveness of whole programmes and their various components (Harvey, 1998:18).

As early as 1963, Cronbach (1963:672-673) defined evaluation as:

“… the collection and use of information to make decisions about an educational program. The program may be a set of instructional materials distributed nationally, the instructional activities of a single school, or the educational experiences of a single pupil … course improvement deciding what instructional materials and methods are satisfactory and where change is needed …”

According to Delclos and Hartman (1993:92), evaluation of interactive multimedia applications should include attitudinal and behavioural components. Attitudinal assessment focuses on learner and lecturer views towards multimedia tools and technology, whereas behavioural assessment focuses on learner performance that can be measured qualitatively and quantitatively.
3.3 EVALUATION DESIGN

This research was split into two main phases, namely the “instructional phase” and the “evaluation phase”. Learners received training (CBT or IBT) in the instructional phase. During the evaluation phase the effectiveness of the training was evaluated by means of online tests (pre- and post-tests) as well as an online questionnaire. In this research, evaluation forms an important part in the assessment of the CBT module. Not only was it a requirement to determine the effectiveness of CBT on learner performance, but changes had to be made to the module in terms of the particular level being evaluated.

3.3.1 Four levels of evaluation

Kirkpatrick (1959a, 1959b, 1979, 1996) identified four levels at which training programmes should be evaluated namely, reaction, learning, behaviour and result.

Step 1 – Reaction: Reaction is defined as how well learners like a training module. Reaction measures learners’ feelings/enjoyment towards their learning experience, however it does not measure any learning that took place.

Step 2 – Learning: The following guidelines should be followed to measure learning:

- Measure the learning of each learner so that quantitative results can be determined.
- Use a before-and-after approach so that learning can be related to the module.
• Where possible a control group (not receiving the training) should be used to compare with the experimental group (that receives the training).

• Where possible, results should be statistically analysed so that learning can be proven in terms of correlation or level of confidence.

Step 3 – Behaviour: Evaluation of training in terms of on-the-job behaviour is more difficult than reaction and learning evaluations. It requires consideration of many factors. The following guidelines should be followed to evaluate training in terms of behavioural changes:

• Conduct a statistical analysis to compare before-and-after performance and to relate changes to the training.

• Conduct a post-training appraisal three months or more after training so that learners have an opportunity to put into practice what they have learned. Subsequent appraisals may add to validity of the research.

Step 4 – Results: The objectives of most training applications can be stated in terms of the desired results.

Only three of Kirkpatrick’s (1959a, 1959b, 1979, 1996) evaluation levels were relevant to this research namely, reaction (i.e. how the learner felt about the learning experience), learning (i.e. what the learner has learnt) and results (i.e. if the desired outcomes have been met). Reaction measurement is facilitated by asking learners to complete a questionnaire. In this research learners in the experimental group had to complete an online questionnaire to determine their overall attitude towards the CBT module (formative evaluation). Furthermore, learners had to complete online pre- and post-tests to measure what they have learned from the CBT module (summative evaluation). As a rule learning is determined by
using an outcome assessment in the form of test scores (Leung, 2003:124).

### 3.3.2 Ten stages of software evaluation

Ten stages were executed during the evaluation of the CBT module. Each stage is briefly discussed and is reflected in Figure 3.1 (adopted from Anon., 2004).

- **Stage 1** - Determine the educational needs of the target group, and decide whether CBT is the best delivery method.

- **Stage 2** - Decide on the basic pedagogical approach and produce a working model of the CBT module.

- **Stage 3** - Find out if the CBT module meets the aims determined in the first stage, and determine how the module can be made more efficient, enjoyable and effective.

- **Stage 4** - Make changes in the CBT module to solve the problems raised during formative evaluation.

- **Stage 5** - Separate learners randomly into experimental and control groups, and test their competence in the area which the CBT module is designed to reach. This stage should only be used if a clearly identified skill is being taught.

- **Stage 6** - Run a fully-fledged programme using the CBT module, and focus on the processes at work.

- **Stage 7** - Re-test the control and experimental groups, and determine if there is a statistically significant difference between their test scores.
• Stage 8 - Determine the adequacy of the CBT module for learner needs.

• Stage 9 - Decide if the CBT module provides education for the learners in a way which is efficient and effective for them, and whether to continue implementation.

• Stage 10 - Determine the long term effects of the CBT module on the learners.

Figure 3.1: Ten stages to follow when evaluating software and its effects on learning
(Source: Anon., 2004)
3.3.3 Effectiveness measures

Table 3-1 illustrates two examples of effectiveness measures used in this research.

Table 3-1: Effectiveness measures (Source: Harvey, 1998)

<table>
<thead>
<tr>
<th>CBT MODULE OBJECTIVE</th>
<th>MEASURE OF EFFECTIVENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner learning</td>
<td>Test scores in appropriate domains utilising appropriate test instruments.</td>
</tr>
<tr>
<td>Learner satisfaction</td>
<td>Learner assessment of CBT module on appropriate instrument to measure satisfaction.</td>
</tr>
</tbody>
</table>

Evaluation is a broad term and can investigate:

- How well an application functions during the development process.
- Existing courseware to determine whether it is useful in a specific programme.
- The effectiveness of CBT (Frith, 1997a).

As in a study by Kennedy et al. (1998), the criteria produced to evaluate the CBT module in this research were based on theories of learning, instruction, and evaluation criteria researchers have used in the past. As opposed to restricting the evaluation to a particular approach or theoretical model, key and general features which emerged from the literature review were utilized to form the criteria for the evaluation. This controversial approach was necessary in order to incorporate the various characteristics associated with multimedia instruction and programming instruction.
3.3.4 Formative and summative evaluation

3.3.4.1 Formative evaluation

Formative evaluation, also referred to as pilot testing, field testing or usability testing (Paragraph 3.7.6), is the evaluation of the application by making use of representatives of the target population, while it is still being developed (McConnell & Schoenfeld-Tacher, 2001; Whitelock, 2000). Hohmann (2003:72) and Löwgren (1993:52) define usability testing, also called usability evaluation as, “the process of studying the usability of a prototype or system”. There currently exist a variety of usability evaluation techniques like usability testing methods, usability inspection methods and usability inquiry methods. These evaluation techniques present evaluators with data, both quantitative and qualitative (Balasubramanian, 2002). According to Hix and Hartson (1993), formative evaluation is used to evaluate and address problems (if any) at an early stage of the design process.

Löwgren (1993:53) is of the opinion that evaluation during the development of CBT modules provides input for the next cycle. Löwgren (1993) further states that formative evaluation has two purposes. Firstly, to find the usability problems in the evaluated product and to get ideas about how they could be dealt with in the redesign. Secondly, to measure if the product fulfils the usability goals.

This type of evaluation ensures a more professional-looking application and it supplies valuable encouragement and ideas for improvement (McConnell & Schoenfeld-Tacher, 2001). Van Greunen and Wesson (s.a.) state that it is not always possible to perform extensive usability testing in laboratories throughout the design process. Therefore, other evaluation methods such as questionnaires can and should be used.
A learner’s perception of the module is critical to his motivation to learn (Kennedy et al., 1998:412). Due to the various responses to change, it is important to determine what the opinions are of learners regarding the CBT module. This must be considered when the learners adopt new technologies and how they respond to this change (Eilers, 2002). In this research, formative evaluation data was collected to revise, refine and improve the CBT module to make it more effective and efficient. Formative evaluation helps to collect information during the development of training applications, which can be used to improve the effectiveness of the training (Dick & Carey, 1996; Draper, 1996; Guba & Lincoln, 1981; Lee, 1999).

In addition, formative evaluation can be used to transfer information back into the original work to both strengthen and move it forward (Harvey, 1998:9). Formative evaluation can be considered as a theoretical base of usability testing (Lee, 1999:21), and forms an essential part in developing multimedia modules (Laurillard, 1994b).

### 3.3.4.2 Summative evaluation

Summative evaluation is performed at the end of the application development after all revisions have been completed (Laurillard, 1994a; Nordhoff, 2002:27; Whitelock, 2000). After implementation of the application, user feedback should be gathered (Nordhoff, 2002:27). During summative evaluation the completed application is evaluated to determine how good it is (Löwgren, 1993).

According to Dick and Carey (1996), summative evaluation is carried out to verify the effectiveness of instructional material with target learners. The aim of summative evaluation is to determine the impact and outcomes of a particular application (Guba & Lincoln, 1981). In order to perform a summative evaluation, an experimental design should be developed and
data collected from target learners. This should be used to verify the
effectiveness of the training material in terms of the instructional goal,
behavioural objectives and learner attitudes toward CBT. According to
Harvey (1998), information is intended to give an overall picture at the end
of a stage in summative evaluation. Furthermore, summative evaluation
“may provide a measure of success or otherwise against original
objectives and planned outcomes or it may include reactions from
participants to a goal free investigation” for example pre- and post-tests
(Harvey, 1998:9). The summative evaluation method selected for this
research is the “field trial” method.

3.4 FIELD TRIAL

Evaluation in this research served as a useful “needs analysis” for further
CBT module development. It also highlights the strengths and
weaknesses of the module, and identifies potential improvement areas.
Furthermore, evaluation is viewed as an integral part of the research in
both the evaluation of the prototype CBT module to make changes if
necessary, and to determine the effectiveness of the instruction.

Compared to a laboratory experiment, the main advantage of the field trial
method is that the learners can access the CBT module from any location
at any given time (Åberg & Shahmehri, 2000; Belanger & Jordan, 2000:10;
Romiszowski, 1997). In the field trial method, comparative experimental
testing was used, which can compare two different types of teaching
methods (CBT vs. traditional classroom-based instruction) (Draper, 1996).
According to Draper (1996), comparative experimental testing tests some
education intervention (such as a CBT module) by means of a direct
comparison of its performance against that of some reasonable alternative
(such as traditional classroom instruction).
To evaluate the extent to which the module achieves a certain set of learning objectives, a pre-test versus post-test experimental design was formulated. This comparative approach has the potential to demonstrate the effectiveness of the educational intervention (Gnisci et al., 1999). Before the start of the evaluation, an explanation was provided to the learners on what the evaluation research is about, and how the data that has been collected, will be used. Previous research has shown that learners dislike performing badly in pre-tests (Draper, 1998). It was therefore made clear to the learners that it was the CBT module which was being evaluated and not them.

The field trial in this research consisted of four parts. Firstly, all learners had to complete an online test (pre-test) prior to either receiving classroom-based instruction or CBT instruction. The pre-test served to measure the baseline knowledge of the learners. Secondly, the learners had to work through either the CBT module during a two-week period (experimental group), or they had to attend classroom-based instruction (control group). Thirdly, after the two-week period, all learners had to complete another online test (post-test). Finally, only learners who made use of the CBT module had to complete an online evaluation questionnaire. Table 3-2 illustrates the experimental design used in this research.
Table 3-2: Comparative experimental design

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Group 1 = Control group  
Group 2 = Experimental group  
R = Random selection of class groups to group 1 or 2  
T1 = Pre-test  
T2 = Post-test  
X1 = Classroom-based instruction  
X2 = Computer-based training (CBT)  
Q1 = Questionnaire

3.5 PARTICIPANTS

A total of 206 learners participated in this research (n = 206). Learners at the CPUT who enrolled for the DOS1 subject are academically and culturally diverse. To the majority of these learners English is a second or third language.

An empirical quantitative evaluation involving one control group and one experimental group has been adopted for this research. As discussed in Section 1.5, class groups were randomly assigned to either the control group (n = 112) or experimental group (n = 94). The random selection of class groups, as opposed to individual learners, ensured consistency between the two groups with regard to the profile of the learners. Between-group randomisation rather than within-group randomisation also minimized the interaction between the CBT and traditional groups. Random selection of learners further ensured homogeneity between the groups; therefore, differences between the groups were very unlikely (Balasubramanian, 2002). According to Vivekananda-Schmidt et al. (2004:49), random sampling may be the most accurate methodology.
available to tackle the hypothesis. Groups were randomly selected based on subject scheduling, required lab time, and lecturer availability (Jeffries et al., 2003:73). It is important to understand the profile of the proposed learners, to ensure that the specific needs of the learners can be incorporated into the user interface design from the beginning (Bevan, 1999).

3.6 PROTOTYPE CBT MODULE

A well-designed, interactive, multimedia CBT module was perceived as one way to complement traditional classroom-based instruction. A CBT module that is well-designed is easy to interpret, understand and it contains visible clues to its functions (Lee, 1999:21). McGee et al. (1998) believe that well-designed modules can consistently allow learners to increase their ability to remember and use information by 15 – 20% or even more. According to Aly et al. (2004:45), a non-linear approach of using an interactive multimedia CBT module can accommodate the diverse learning styles, experiences and knowledge bases of learners. A mix of media satisfies the many types of learning preferences that a learner or group may represent (Farmer, 1995).

Authoring software selection depends on existing hardware configurations, and whether to buy commercial courseware products or custom-made courseware (Gaytan & Slate, 2003). Commercial products did not address our specific needs in teaching DOS1, so the author, together with FireFli Web Creations (a South African graphic design company), developed a CBT module for this purpose. When the decision was made to develop the CBT module, no similar modules were offered online.
3.6.1 Development of prototype CBT module

The development of the prototype CBT module consisted of several tasks. Firstly, a storyboard was drawn up to get an idea of how the prototype module should look and react on user actions. It involves careful consideration on how the learner would react to each screen. Storyboards and prototypes are essential planning tools for multimedia development (Deacon et al., 1997). “Prototyping is about people” (Lantz, 1987). Furthermore, prototyping enables the learners to see an application and “play” with it before it is implemented. According to Hom (1996), prototyping models the final product and allows one to test attributes of the final product. Hom (1996) further states that prototyping allows you to simply test using your model.

Advances in technology and software are making an increasing impact on education curricula, learning materials and instructional practices (Hartley & Collins-Brown, 1999:12). Technology also allows lecturers to design and develop the majority of the CBT material themselves (Aly et al., 2004:43). Implementation of multimedia applications in educational contexts requires careful planning in application design, integration of content into the curriculum and delivery. Planning of all stages is essential if a viable and sustainable product is to be developed (Deacon et al., 1997). Barron (1998:359) points out that, if the focus is not on the content, the strategies, and the learning experiences of learners, the effectiveness of the application will be lost, regardless of the medium or the authoring environment.

Secondly, the first prototype was developed in Microsoft PowerPoint 2002 (Figure 3-2). PowerPoint allows for rapid prototyping of modules in an academic institution, because it allows the development of material while the programme runs and evolves (Tripp & Bichelmeyer, 1990). The first PowerPoint version of the CBT module represented a single unit with
sound and graphics for each lesson in a single file. It was found that the PowerPoint development environment was sufficient and flexible enough for the requirements, but later opted to adapt a more professional approach by consulting a graphic design company. This company re-created the PowerPoint prototype by using Macromedia Flash.

The second Flash prototype version allows for changes and corrections to be made only to those parts of the lesson that requires modification. In contrast to the PowerPoint prototype module, the Flash module was modularised into lessons. A benefit associated with modularising the lessons is that it makes it easier for the learners to select their starting point in a lecture or repeat a lesson section more easily.

Figure 3-2: Module introduction screen for PowerPoint CBT prototype

The principles for developing good multimedia modules include knowledge of the audience, and the purpose of the title is to facilitate the design of the modules to serve both entities. The main goal of multimedia development
is to get the right “look and feel”, as multimedia is more visual than verbal (Whalen, 1998). Dowie (2003) lists several qualities of effective instructional multimedia material, which have been implemented for the CBT module in this thesis:

- The module should be compelling for learners: Novelty is used to enhance motivation, and learners are also shown how what they learn, will help them to solve problems.

- The module should be academically credible: Information contained in the module should be current and accurate.

- Learners should know what to expect: The goals of instruction must be clear to learners and what is expected of them as they navigate through the module. This reduces learner uneasiness and allows learners to judge what the relevant and important goals of instruction are (Overbaugh, 1994). Learning objectives are stated as part of all major units of instruction (Ambler, 2000:1-3).

- Consistency: Menus, buttons, and other controls should be used consistently throughout the module. Learners are informed of their “location” in the module through the use of titles and screen numbers. Learners also determine the sequence of information they wish to peruse. Consistency allows learners to build a mental model of the way the user interface works (Ambler, 2000:1-3; Aspillaga, 1996; Kantner, Shroyer, & Rosenbaum, 2002:5-7; Lee & Boling, 1999; Nielsen, 2003, 2005; Ramsey, 1996:6; Russell et al., 1999).
Herrington and Oliver (1997) note three purposes of navigation:

- To allow learners to locate and access particular information.
- To allow learners to purposely move between related information.
- To allow learners to establish their current position within the module.

A consistent and understandable navigation system is therefore crucial to ensure an effective CBT module (Kennedy et al., 1998:410) (Paragraphs 3.6.4 and 3.7.3)

- The visual layout should promote learning: Content should be broken down into units that are small enough to be learned easily, while the text must be organized into short, easy-to-read paragraphs. According to Nielsen (1995:154), “reading from a computer screen is about 30% slower than reading from paper”. This results in learners not reading long blocks of text comprehensively (Soboleva & Tronenko, 2002:490).

- Multimedia elements should be used wisely: A variety of mediums should be used to effectively illustrate facts, concepts and procedures. Furthermore, graphics, fonts, and other visual elements should be clear, purposeful, and attractive.

- The module should support active learning: Learning objectives should be matched with appropriate learning activities. Learners should be provided with opportunities to verify their level of understanding, while explanatory feedback is provided for correct and incorrect responses.
Navigation: Navigation refers to finding the relevant information in a CBT application (Klett, 2002:42). If learners find it difficult to move between screens, they will quickly become frustrated and may even stop using the module (Ambler, 2000:1-3; Kantner et al., 2002:5-7; Nielsen, 2005; Reeves, 1997). This is a critical factor, because learners often complain of being lost within the context of an interactive application (Utting & Yankelovitch, 1989).

The CBT module was developed to complement existing programme material, to make it clearer, visual and self-paced, and to provide learners with an interactive means of self-study and self-evaluation. Every effort was made to maintain a constant content and presentation sequence for the control group and experimental group. This ensured that the only difference in the two teaching methods amongst the two groups was the “type of delivery system”. Developing the multimedia CBT module required a considerable amount of development time, which can be discouraging to lecturers. To compensate for this, the module should be usable for a considerable period of time (Beckstrand, 2002:78).

3.6.1.1 Animated pedagogical agent

A major problem in the design of the Flash CBT module emerged to the fact that the “Help function” in PowerPoint could not be incorporated into the Flash environment. The “Help function” in PowerPoint is a useful animated function (animated pedagogical agent, guide or character) that introduces learners to the module, guides them through the navigational functions, and shows them how to click the buttons on the screen. (Figure 3-3) Guides represent interface agents which act as “companions” to the learner and can assist with screen navigation by explaining or suggesting options the learner can choose at any particular time (Ramsey, 1996:7). Furthermore, they are considered realistic autonomous characters that cohabit the learning environment creating a rich user interface for learners.
Animated pedagogical agents represent the most recent generation of Human-computer interaction (HCI) design. HCI is concerned with the design, evaluation and implementation of interactive computing systems. Animated pedagogical agents differ from pedagogical agents, because their appearance is like an animated character. They are autonomous agents that support the learning process by interacting with learners in the interactive training application (Nunes et al., 2002:54). Animated pedagogical agents produce a new level of interactivity. They work in an interactive way with the learner by using dialog. The text attributed to each of the agents is presented in “speech balloons” prompting the learner to act, how to continue, repeat, stop the module etc. Animated pedagogical agents also improve the efficiency level and cognitive process of the instruction processes. Furthermore, they individualize the learning process and promote learner motivation (Johnson, 1998).

Figure 3-3: Animated agent used in the PowerPoint CBT prototype
An animated pedagogical agent can stimulate learners, and has the power to offer a wide spectrum of educational interaction with learners. It can in addition illustrate gestures and facial expressions to focus learner attention on the learning process (Baer, 1999). By using an animated pedagogical “agent”, the learning environment is transferred from a simple training system to a more constructionist educational environment. These “agents” also ensure personalized learning, and thus lead to a positive effect on the learning process.

In this research learners can access the animated agent at any point where the “Help function” is present on a screen. The differing needs of different learners can be catered for very effectively through such an animated agent, which allows optional access to further levels of explanation (to access more background information or more practical examples).

### 3.6.2 Prototype process

Ambler (1998, 2000:4, 2001) defines prototyping as an iterative analysis technique in which users are actively involved in the mocking-up of screens. A prototype’s purpose is to show people the possible design(s) for the user interface of an application. According to Pichler (2002:2-3) the user interface is the most important part of educational applications. The user interface builds the connection between the learner and the material and is a kind of substitute for the lecturer. Sherson (2002:3) adds to Pichler’s (2002) statement by saying that the user interface has to create a virtual world for the learner, where they can feel comfortable, engaged, and in control.
The prototyping process consists of four steps and was followed in this research (Ambler, 2000:4):

- **Step 1:** Determine the needs of learners. Learner requirements which can be gathered by means of interviews drive the development of the prototype module.

- **Step 2:** Build the prototype. During this stage screens are developed for the module.

- **Step 3:** Evaluate the prototype. After development of the prototype, it must be evaluated, to determine if it meets the needs of the learners.

- **Step 4:** Determine if the prototype is complete. The prototyping process is terminated when the evaluation process does not generate any new requirements, or if it generates a small number of less important requirements.

### 3.6.3 Alpha and beta testing of prototype CBT module

Development applications as a rule go through several testing phases. During alpha testing, the developers test the prototype and correct technical and design defects in the application. It is a process of error detection and correction (Thurston & Cauble, 1999:301). Alpha testing is followed by beta testing, which a select group of learners (Deacon et al., 1997) perform. During beta testing, learners complete the module and give feedback on their experience. Learners also help to identify problems with the content or delivery. After beta testing, modifications are made to the module based on the input received from the learners during beta testing (Thurston & Cauble, 1999:301).
In this research, learners who have successfully completed the DOS1 subject in 2003 performed beta testing. The selection of participants (their background and abilities must be representative of the application’s intended users) is a crucial element of a successful usability evaluation. The evaluation is valid only if the participants being evaluated are typical end users of the application or as close to a selected set of characteristics as possible (Pieratti, 1995b). By making use of real users ensured that the intended learners of the module can carry out the intended tasks in an effective, efficient and satisfactory manner (Gaffney, 1999; Pieratti, 1995b). The purpose was to conduct an informal evaluation on the initial design of the CBT module. Learners could provide feedback on any aspect of the module. The objective was to validate whether the design concept met learner needs. Only five participants were selected to participate in the usability evaluation process. Nielsen (1993) recommends the use of four to five subjects for an evaluation stating redundancy in results from evaluation above that number. Questionnaires and informal interviews were used to collect responses and ratings on learner satisfaction and interface usability.

Usability testing is used to do experiments to find out specific information about a design (Hom, 1996), and to improve the usefulness of applications during its design and development (Pieratti, 1995b; Van Greunen, 2002). Since most people are uncomfortable when they participate in a laboratory experiment and their behaviour is logged for analysis, it is very important to set the participants at ease (Hom, 1996). This obstacle was bridged by explaining to learners in detail the purpose of the experiment.
3.6.4 User interface design

User-centred design has gained prominence in both industry and academia. According to Norman and Draper (1986), it is well-known that learner input is required to ensure a successful CBT module. The principle of user-centred design is to involve the learner in the design decision process of a particular software product, and to understand and address learner needs (Rubin, 1994). Design guidelines are developed by considering the needs, expectations and enjoyment of learners. Designers of CBT material should design to fulfil these user-centred concepts (Russell et al., 1999).

Balasubramanian (2002:1) defines user-centred design as “designing for the user and involving the user in the design process”. If user-centred design is integrated into the development, implementation and testing of multimedia courseware, it will ensure that the benefits ultimately come back to the learner (Eilers, 2002).

Norman (1990) identifies two key principles that ensure user-centered design namely, “visibility” and “affordance”. Visibility refers to correct parts being visible and conveying the correct message, while affordance provides strong clues to the operations of things. Preece, Rogers, Sharp, Benyon, Holland and Carey (1994) state that controls must be visible and its design should suggest its functionality.

The prototype CBT module was used to show learners the possible designs for the user interface. The graphical user interface (GUI) is important as it has to be both simple and attractive; otherwise, learners will not use the tool (Abraham, Crawford, Lesta, Merceron & Yacef, 2001). Tognazzini (2003) states that effective interfaces are visually apparent and forgiving, and that it gives learners a sense of control. An effective interface does not concern the learner with the inner workings of the
system, it requires a minimum of information from learners. According to Ambler (2000), it is important to realise that users want developers to build applications that meet their needs and that are easy to use. The user interface design process starts with asking questions such as: Who are the users? What are the tasks? (Shneiderman, 1997, 1999). CBT applications must address learner needs, culminating in the analysis of the target population being of great importance. This analysis will furthermore provide a good idea of who the learners and their needs are (McConnell & Schoenfeld-Tacher, 2001). Learners must see that CBT materials are relevant to the programme, and that it is part of the programme requirements. CBT modules should not just be an optional unrelated extra to the programme (Deacon et al., 1997).

Devitt (1994) proposed the following requirements for CBT applications:

- The application should be relevant and applicable to the curriculum.
- The software should be easy to use by learners.
- The learning process should be interactive and self-paced.

Frey and Soloway (1987) are of the opinion that the user interface is important for educational software, because it should provide an entry to the content domain and be sensitive to the general skill and development level of learners.

The user interface links the user’s actions with the underlying functionality of the system. Constantine (1995) postulates that a good user interface allows people who understand the problem domain, to work with the application without having to read the manuals or receive training. Calitz and Taljaard (2000) state that the user interface plays an important role in application development.
Good user interface design includes good language use, layout, and graphics in order to enable the learner to easily access, understand and retain programme content (Nelson, 1997:13). An intuitive user interface results in ease of use. The better the user interface, the more likely learners will use it and as a result indirectly increase their satisfaction (Ambler, 2000; 2001:1). To encourage and support learning, and heighten learner motivation, CBT materials must be of interest to learners, which will ensure that learners continue to want to learn. Learning materials must be structured with care in order for learners to feel that using the CBT materials are valuable and rewarding. The desire to learn has to be strong in online learners because of the high degree of learner control involved and the amount of responsibility that learners take for their own learning in the online environment (Stansfield et al., 2004:176).

Aspillaga (1996) points out that consistent placement of information controls learner attention, improves performance and accuracy, and enhances learning. Consistent use of colours, fonts, headings and typography can assist in making navigation and processing a lot easier for learners (Head, 1999). If the user interface is not well-designed, the learners will have little opportunity to learn from the application (Reeves, 1997). An intuitive, easy to use interface can overcome some of the training issues which learners have who are not as technically skilled as others (Hartley & Collins-Brown, 1999:18). While functionality of an application is important, the manner in which it provides functionality is of equal importance.
Several authors list the following user interface design tips:

- **Wording of messages and labels:** Text on screens is a primary source of information for learners. If text is worded poorly, the interface will be perceived poorly by the learners. Full words and sentences instead of abbreviations make text easier to understand. Messages should be worded positively, implying that the user is in control, and providing insight into how to use the application (Ambler, 2000:1-3; Nelson, 1997).

- **Use colour appropriately:** Colour should be used sparingly in the module. Colours must also be used consistently to ensure a common look and feel throughout the module (Ambler, 2000:1-3; Head, 1999; Nielsen, 1993; Ramsey, 1996:6; Russell et al., 1999). Colour is useful for indicating different kinds of information (Preece et al., 1994; Shneiderman, 1997, 1999). A change of colour should signal a change in information type.

- **Follow the contrast rule:** When using colour, it must be ensured that the screens are readable. To ensure readability, it is best to follow the contrast rule: use dark text on light backgrounds and light text on dark backgrounds (Ambler, 2000:1-3; Russell et al., 1999).

- **Use fonts appropriately:** Fonts must be easy to read, and must be used consistently and sparingly (Ambler, 2000:1-3; Head, 1999; Nielsen, 1990b, 2003; Ramsey, 1996:6; Russell et al., 1999).

- **Do not create busy screens:** Crowded screens are difficult to understand and use. Research by Mayhew (1992) shows that the overall density of the screen should not exceed 40%, whereas local density within groupings should not exceed 62% (Ambler, 2000:1-3; Russell et al., 1999).
• Sequencing: Sequencing refers to the flow of content and information in the multimedia CBT module. Hannafin and Peck (1988:303) argue that content flow is critical to the ease with which learning will occur, and will likely maintain learner attention effectively.

Galitz (1997) also supplies a few GUI design guidelines that can be applied in the user interface design of an application, and addresses principles pertaining to aesthetic appeal, clarity, compatibility, comprehensibility, consistency, efficiency, predictability, responsiveness etc. Lohr (2000) also specifies similar design guidelines in his work. Schwier and Misanchuk (1993) state that the combination and application of various aesthetic principles to information presentations, ensure that the information has embedded qualities of elegance, harmony, unity and balance. Other important guidelines include Nielsen’s (1992, 1993) heuristics such as simple and natural dialog, consistency, shortcuts, feedback, help, and minimization of memory load etc.

Nielsen (2005) describes ten general principles/heuristics for user interface design, which are widely used by other researchers as well:

• Visibility of system status: The system must at all times keep the user informed about what is going on through appropriate feedback within reasonable time.

• Match between system and the real world: The system should use words, phrases and concepts familiar to the user, rather than system-oriented terms. Information must appear in a natural and logical order.
• User control and freedom: Enable the user to exit from the application when he makes a mistake. Support undo and redo actions (Russell et al., 1999). According to Klett (2002:43), learning is most efficiently achieved when the learner knows his aim, pursues it and proficiently controls his own actions. Gloor (1992) states that an effective feature of multimedia instructional aids, is a high degree of user control. Learners learn more quickly and gain a fast sense of mastery when they have control over the learning process (Tognazzini, 2003). In this research learners were given full control over the CBT module (Paragraph 2.4.3).

• Consistency and standards: Users should not have to “wonder” whether different words, situations, or actions mean the same thing. Platform conventions must thus be followed (Paragraphs 3.6.1 and 3.7.3).

• Error prevention: The application should be designed to prevent a problem from occurring (Nielsen, 1990b, 2003; Russell et al., 1999; XEROX Corporation, 1996).

• Recognition rather than recall: Minimize learner memory load by making objects, actions and options visible, and ensure that screen elements are meaningful and consistent across screens. The learner should not be required to remember information from one part of the dialogue to another (Nielsen, 1990a). Make instructions for system use visible or easily retrievable whenever appropriate (Katz-Hass, 1998; Nielsen, 1990b, 2003; Reeves, 1997; XEROX Corporation, 1996). To avoid cognitive overload (when too much information is presented at once), the number of learner choices should be kept in the 7±2 guideline. Information overload can be avoided by applying the 7±2 guideline (also referred to as Miller’s Number). This rule derives from psychology research, which shows that the number of information “chunks” that a learner can retain
and manipulate at once varies between five and nine. A large number of “chunks” thus results in information overload (Satzinger, Jackson & Burd, 2004).

- **Flexibility and efficiency of use:** Accelerators may speed up the interaction for the expert user to the extent that the system can cater for both inexperienced and experienced users. Allow users to tailor frequent actions (Kantner et al., 2002; Nielsen, 1990b, 2003; Russell et al., 1999; XEROX Corporation, 1996).

- **Aesthetic and minimalist design:** Do not include dialogues with irrelevant or rarely needed information (Kantner et al., 2002; Nielsen, 1993). Aesthetics refers to the artistic aspects of interactive programs (Reeves, 1997).

- **Help users recognize, diagnose, and recover from errors:** Express error messages in plain language (no codes). Accurately indicate the problem and suggest remedial action.

- **Help and documentation:** It is always more appropriate if a system can be used without documentation, but it may be necessary to provide help facilities and documentation. Such information should focus on the user’s task, be easy to search, list specific steps to be carried out, and not be too cumbersome.

Katz-Hass (1998), Nielsen (1990b, 2003), Russell et al. (1999) and XEROX Corporation provides additional guidelines for user-centred web design. Though these guidelines are mainly used for web pages, some of these guidelines were applied to this research, namely:

- **Visibility:** Important elements such as navigational aids should be highly visible.
• Feedback: Should a learner perform an action, immediate feedback should be received (e.g. when a learner clicks on a button, something on the screen should change to inform the learner that the module has registered his click action). Tognazzini (2003) refers to “latency reduction”. The learner’s experience of latency must be reduced by acknowledging for example all button clicks by visual or aural feedback.

• Satisfaction: The module must be pleasant to use and to look at. Learner perceptions of “pleasantness” influence the perception of ease-of-use, motivation for learning of how to use the module, and confidence in the reliability of the module’s information.

3.7 USABILITY

Usability is an important component of user-centred design. Newman and Lamming (1995) argue that usability is the key for interactive system design. Usability is defined in ISO/IEC 9126 (1991) as:

“Usability: a set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users”.

Preece et al. (1994) state that usability is a key concept of the human-computer interface. Usability is concerned with making software easy to learn and use through a user-centred design process (Abels, White & Hahn, 1997:253; Pieratti, 1995a; Sherson, 2002:4).
Preece *et al.* (1994:722) define usability as:

“... a measure of the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and attitude of its users toward it.”

Preece (2001) further states that usability supports rapid learning, high skill retention, low error rates and high productivity. Furthermore, it makes software pleasant and effective to use, and relates to learner satisfaction towards CBT material (Chapanis, 1991; Gnisci *et al.*, 1999:436; Pieratti, 1995a). Usability is an important component for the success of any software (Fenton, 1991; Pichler, 2002). Good usability also supports learner creativity, improves productivity and induces a feeling of well being. The ISO 9241-11 (1998) standard defines usability as “the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments.”

Borälv’s (2001) definition of usability maps to that of the ISO 9241-11 (1998) standard. The concept of usability is defined by Borälv (2001) as the extent to which an application can be utilised by learners to attain goals with effectiveness, efficiency and satisfaction in a specified context of use. Effectiveness refers to “the accuracy and completeness” with which learners attain goals, whereas efficiency refers to “the resources expended in relation to the accuracy and completeness with which users achieve goals” (Borälv, 2001; Van Greunen & Wesson, s.a.). According to Garzotto, Matera and Paolini (1998:6), efficiency concerns features that support successful achievement of learner goals, with a high level of productivity. Satisfaction refers to the comfort and acceptability of the system to its users.
Usability is commonly defined as a combination of learnability, ease of use, usefulness, and pleasure. Usability mainly applies to general features such as hardware, software, interface design, choice of icons, menus, messages, documentation, training, interaction style, and on-line help (Nielsen, 1993; Pieratti, 1995a; Shneiderman, 1992).

Nielsen (1993) terms usability as an attribute that comprises, however not restricted to, effectiveness, efficiency, learnability, and low error rate (Nielsen, 1990a, 1990b). Other authors relate usability with satisfaction with the interface that is being evaluated (Nielsen 1990a), performance effectiveness, and flexibility (Lindgaard, 1994). Hohmann (2003:66) describes usability very similar to that of Nielsen (1990a, 1993). According to Hohmann (2003), usability is a complex set of choices that ends up allowing the users of the system to accomplish one or more specific tasks, easily, efficiently, enjoyably, and with a minimum of errors.

Shneiderman (1997, 1999) formulated three general principles for software usability, namely:

- **Consistency**: Colour, layout and typography should be applied consistently throughout the module (Paragraphs 3.6.1 and 3.7.3).

- **Control**: Learners want control over the CBT module in order to allow flexibility to move within the module (Paragraph 2.4.3).

- **Predictability**: Ensure that software is consistent and controllable, as this ensures that the software is predictable. Predictability further enables the learners to continually build on their experience.
According to Ficarra (1996), the minimal criteria when designing an interactive product for learners are summarized as follows:

- Ease of use (Can a learner use the product with minimal help?).
- Educational rating (What can a learner learn from this product?).
- Entertainment rating (Is this product fun to use?).

It is impractical to design applications that will ensure a high degree of usability if learner needs are not considered in the early stages of software development (Benjamin, 2000:2). The adherence to user interface design standards, and the consistency of design philosophies throughout an application, contributes to the overall usability of the software (Benjamin, 2000:8). In general, consistency is acknowledged as one of the most important usability principles. This means that conceptually, similar elements are treated in a similar way, while conceptually different elements are treated differently (Constabile, Garzotto, Matera & Paolini, s.a.).

3.7.1 Factors for perceived usefulness

Davis (1989:319) demonstrated that perceived ease of use and usefulness, are fundamental determinants of user acceptance. Lim and Benbasat (2000:457) define perceived usefulness, “as the degree to which people believe using a particular system would enhance their job performance”. The usefulness of a product is determined by whether the system can achieve a desired goal (Van Greunen, 2002). To develop an effective interactive multimedia CBT module for this research, dimensions of usability testing were categorized under the headings of learnability, performance effectiveness, flexibility, and user satisfaction. Usability testing can be used to improve existing software, to compare two or more products, or to measure the software against a set of guidelines (Lindgaard, 1994). Usability testing provides important benefits in terms of
cost, product quality, and learner satisfaction. It can improve development productivity through more efficient design and fewer code revisions. It can also prevent over-design by only meeting learner needs. Design problems can be identified earlier in the development cycle which could culminate in a saving of time and money. A usable product results in more satisfied learners and a better reputation for the product (Pieratti, 1995b).

Löwgren (1993:53-54) lists several usability methods/techniques of usability testing:

- **Checklists:** These are long lists of aspects to consider in a user interface design. Checklists can be used to evaluate a specific design.

- **Empirical testing:** This is the most obvious form of usability testing where the design is tested on users. The most valid result can be obtained with real users from the target population.

- **Field trial:** This method represents a type of empirical testing with real users, except that users can test the product at will as opposed to conducting tests in a computer room.

Table 3-3 contains elements from Löwgren’s (1993) and Conyer’s (1995) methods/techniques of usability testing, which was applied to this research.
Table 3-3: Methods/techniques of usability testing

<table>
<thead>
<tr>
<th>METHOD/TECHNIQUE</th>
<th>ADVANTAGES</th>
<th>LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical method:</td>
<td>• Effective for finding cause and effect.</td>
<td>• Time consuming and expensive to conduct.</td>
</tr>
<tr>
<td>An experimental test to prove or disprove the hypotheses.</td>
<td>• Effective for addressing a specific question or problem.</td>
<td>• Need to train a skilled practitioner.</td>
</tr>
</tbody>
</table>

In a study by Selim (2003), four major factors for the perceived usefulness of programme websites are identified, and furthermore applied to this research:

- Programme/coursework interactivity: The programme author must list the website usefulness factors of asynchronously\(^5\) delivered programme material that:
  - Allow learners to retain control as to when and where they use the programme material.
  - Allow programme materials to be downloaded in different formats via the programme website.
  - Allow websites that include links to related materials and websites to widen the learners’ exposure to current information on their topics.
  - Provide learners with animation and multimedia that enable them to complete their programme work quickly.

\(^5\) Asynchronous delivery refers to delivery of the course material precedes receipt of content material by the learner (Graves, 1997).
• Makes studying programme material easier by making the material readily available, facilitating learner-to-learner and learner-to-lecturer communications, and using interactive tools to explain programme content.

• Increase learner productivity and effectiveness. This is a result of enabling learners to finish their programme work more quickly and achieving their objectives efficiently, using the tools available on the programming website on WebCT.

3.7.2 Learnability

For a newly developed module, learnability can mean the difference between adoption and rejection (Kantner et al., 2002:4). Garzotto et al. (1998:6) list two general usability principles, namely “learnability” and “efficiency”. According to Dix et al. (1993), learnability concerns the features of an interactive application that allows novice learners to use it initially, and then to attain a maximum level of performance.

Lindgaard (1994:30) refers to learnability as the ease with which new or occasional learners may accomplish certain tasks. This means that learners rapidly are able to understand the most basic navigational functions and to use them to locate required information. The various combinations of media elements enable lecturers to create interactive educational content, which results in a stimulating environment for learning and retaining information (Roblyer & Edwards, 2000).

3.7.3 Consistency

Consistency is seen as one of the most important usability considerations (Nielsen, 1989). Screen elements with similar functions must share similar appearance, location and behaviour. Lee and Boling (1999) further state
that consistency can make multimedia courseware easy to learn, use and remember. Consistency can even reduce the effort required to learn new modules. The process of letting the learner know where they are, what they can do, when they are there, and where they need to go next is referred to as “way finding”. By using icons, backgrounds, borders, graphics and screen titles in a complex learning environment, it can assist a learner to find his way through the CBT module (Jones, 1989). By dividing information into sections, the learner would not become disoriented while using the module. Sections provide reference points that allow the learner to determine his position within the software e.g. topic headings (Ramsey, 1996:6). The layout should ensure unity and harmony across the module (Klett, 2001).

3.7.4 Visual design and HCI

Head (1999:9) describes visual design as everything from the traditional concept of using colours that are harmonious when displayed, to the more complex science of HCI. This asserts the need for the development of computer interfaces that are founded upon cognitive and other behavioural factors that come into play when learners interact with computers.

HCI is concerned with the design, evaluation and implementation of interactive products and systems for human use (Greenberg & Carpendale, 1999). The study of HCI assumes that the interaction of person and machine is affected by the characteristics of both the computer system and the person using it. HCI is about making these products and systems easier to use, and to match them more closely to user needs and requirements (Greenberg & Carpendale, 1999). This notion is termed as “usability” as described in Paragraph 3.7.
Costello, Curtis, Joyce and Singer (1995:3) claim that colour is the most important aspect in visual design in CBT material. Even though colour plays an important role in visual design, Head (1999:57) states that fewer colours are better, and that it should be used sparingly. In contrast with Head’s (1999) statement, Lee and Boling (1999:21) suggest that as many as seven colours can be used at once on a screen. Colour should be used consistently. Designers must use their judgement when they select a colour scheme for screens, and they should not waver from their decisions and the content appearance throughout each module (McFarland, 1995).

In a study by Maffei (1995) it was found that adults have a preference for cold colours (e.g. blue, grey etc.), and children for warm colours. Results have shown that claims that blue is the preferred colour in Western countries, were confirmed by 50% of people questioned. Green follows with 20% and white and red follow with 8%. This tendency occurs throughout Western Europe, North America and Australia. Spain is the exception, where red is the preferred colour. In Argentina and Brazil the most favourite colour is blue, ahead of red and white. In Japan the favourite colour is white (40% of those polled) followed by black and yellow. Using Maffei’s (1995) findings for Western Countries, the CBT module was developed to be mainly blue (background), followed by white, yellow and red (text).

In addition Lee and Boling (1999) state that visual design is an important component to increase learner motivation to engage with the learning material. According to Vaughan and Hinshaw (1995) as cited in Torgerson (2000:1), poor visual design drives learners completely away from the courseware.

In CBT, Hannafin and Hooper (1989:158-159) argue that visual design has

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the following five primary functions:

- Focusing attention.
- Developing and maintaining interest.
- Promoting deep processing.
- Promoting engagement.
- Facilitating navigation through the content.

Costello et al. (1995:3) consider visual design to be the most critical factor of successful CBT material. They argue that the visual medium carries the instructional message. Therefore, according to the authors, effective CBT design must first adhere to the principles of effective visual design, and subsequently they specify three objectives of visual design, namely to:

- Attract attention to the application content.
- Present content so that it is easy to understand.
- Impress the information upon the learner.

3.7.5 Interactivity

The importance of interactivity should not be underestimated. It keeps learners focused on the information presented and actively involves them in the learning process (Kennedy et al., 1998:410). Interactivity is when a software application allows the user to participate by providing a response, which involves an information exchange between the user and the computer (Najjar, 1996:131; Neufeldt, 1995). The fact that interactivity can be integrated into multimedia educational content makes it the biggest advantage of using authoring software to create multimedia content. Interactivity allows the learner to interact with the computer and it empowers the individual by letting him control the content and flow of information (Vaughan, 1998). This means that the interactivity allows users to navigate and explore the CBT module at their own pace (Neo &
Interactivity is a major factor that constructs knowledge (Biggs, 1999:93-95) and determines the success of a multimedia product. It has also been found that interactivity can increase retention rates amongst learners and can help learners learn by doing (Blank et al., 2002b). Patel and Russell (2001:117) further state that it is the “learn by doing” and formative evaluation accompanied by feedback, which are essential to any learning system. Hoogeveen (1997) agrees with the statements of Blank et al. (2002b) and Patel and Russell (2001), by stating that the main advantage of multimedia systems is the increased level of interactivity the systems provide. Learner interactivity comes in the form of using navigational aids e.g. buttons, hypertext etc. Wagner (1997) states that interaction focuses on learner behaviours and contributes to the effectiveness of CBT applications (Hannafin & Peck, 1988:8). Interactivity focuses on the characteristics of technology systems and enables learners to communicate with the CBT application (Klett, 2002:41).

According to Thurston and Cauble (1999), assessments with feedback scores, the number of applications to view, and quizzes are examples of interactivity. Questions supplying feedback to the learner is a popular method of promoting interactivity as it enhances the retention of knowledge and addresses remediation of incorrect understanding (Hannafin & Peck, 1988). Feedback to learners can show how they are progressing and on what content they should focus more (Lee, 1996). Before completing the post-test, the CBT group was required to answer extra review questions, to determine which information they had to revisit. El-Tigi and Branch (1997) suggest that all instructional software must provide a teaching/learning environment that supports interactivity and learner-centred control of pertinent information. Such interactivity lends itself to a constructivist approach to learning. This is made possible by online CBT applications where learners have navigational freedom. A
constructivist approach focuses on the learning experiences of the learner. Learning requires the learner “to actively construct personal meaning and understanding while thinking about previous experiences and considering alternative perspectives held by other” (Bednar, Cunningham, Duffy & Perry, 1992). Evaluation of this type of learning determines the effective functioning of a learner in a targeted discipline.

Steuer (1992:80) defines interactivity as the degree to which learners can influence the form or content of the mediated environment. Participation requires learner attention to progress through the module. Learner attention or comprehension is not necessarily guaranteed by passive listening (Issa et al., 1999:281). Issa et al. (1999:281) furthermore point out that participation in multimedia-based models involves four levels of interaction, namely:

- Multimedia triggers a number of senses other than simply listening. People remember 20% of what they hear, 40% of what they see, and 80% of what they see and hear (Paragraph 2.2.1.1).
- The learner has limited input that advances the lesson.
- Interaction allows the learner to control the order and the content of the lesson that most suits his interests and needs (Paragraph 2.4.3).

In a laboratory experiment conducted by Gnisci et al. (1999:440), results have shown that the effects of two multimedia system configurations with a different degree of interactivity on usability aspects and learning performance enabled the learners of both configurations to learn. It is of interest to note that the results proved that learners in the less interactive configuration indicated a higher increase of learning performance than learners in the more interactive configuration.

Hiltz (1994) suggests that the use of an interactive multimedia system
promotes active learner participation. Hiltz (1994) further states that this approach can have a positive effect on learner satisfaction, which can be obtained by increasing the degree of interactivity in the system.

It is important to acknowledge that the criterion of interactivity cannot be satisfied through basic “point and click” procedures or by simply allowing students to use the navigation bar to actively move through the package (Kennedy et al., 1998:410).

3.7.6 The REAL model

Löwgren (1993:52) states that usability is a result of Relevance, Efficiency, Attitude and Learnability (REAL). The REAL model is very similar to the model described by Kirkpatrick (1979, 1996) in Paragraph 3.3.1, and consists of the following elements:

- **Relevance**: The relevance refers to how well a product serves the user’s needs.

- **Efficiency**: Efficiency refers to how efficiently the user can carry out his tasks using the product.

- **Attitude**: Attitude is the user’s feelings towards the product.

- **Learnability**: The learnability of a system is how easy it is to learn and how well the user remembers the skill over time.

3.8 MACROMEDIA FLASH DEVELOPMENT TOOL
In order to develop a suitable CBT module, various authoring systems were evaluated. Based on the evaluation results, it was ascertained that Macromedia Flash was the most suitable for the development of a CBT module for the DOS1 subject. Flash is being perceived by the industry as the standard for creating interactive multimedia content on the Web (Sherson, 2003:2). While Macromedia Flash can be used to enhance programme content and to present learning materials that accommodate a variety of learning styles, too many “bells and whistles” can be a distraction from programme content (McConnell & Schoenfeld-Tacher, 2001).

Macromedia Flash allows for the creation of an integrated learning environment to deliver interactive CBT material. Animation capabilities can add interactivity as well as three-dimensional elements to procedures or concepts. The consistent basic layout and the uniform construction of the diverse lessons, allows for rapid familiarization with the content. Furthermore, animation allows for insight into internal processes or hidden views (Eilers, 2002). This feature makes it ideal for illustrating certain programming processes and concepts in the CBT module for teaching DOS1.

The load speed of the CBT material is relative to the speed of the connection to the Internet, as well as the amount of content on each screen. Even though the designer has no control over the connection speed of a learner to the Internet, he can control the file size by not using a large amount of graphics (Nelson, 1997:23). Flash makes use of vector graphics to develop eye-pleasing, user-friendly interfaces. It allows for quick downloading, because of relatively small, compressed Shockwave files.

3.9 CBT DELIVERY
Probert and Munro (1995:5) state that the successful implementation of CBT in South African higher institutions will be determined by three key factors, namely: lecturer resistance, investment in appropriate hardware and software, and the development of appropriate courseware becoming a priority. CBT material can easily be delivered and distributed by means of CD, intranets and the WWW (Bagui, 1996; Vivekananda-Schmidt et al., 2004:44). On-line instruction can be offered in a variety of formats. The format a lecturer selects will depend on a number of factors such as administrative support, technical knowledge and expertise, technical support, and the technical infrastructure of the delivery location (Cooper, 1999).

3.9.1 WebCT platform

The CBT module developed for this research was delivered via the university’s local network (intranet) as well as on the Internet via the World Wide Web Course Tools (WebCT) platform. WebCT is a teaching module that works within a web browser that allows learners the flexibility of 24-hour access a day, seven days a week (Beckstrand, 2002). According to Nielsen and Tahir (2001), the Web increases accessibility and challenges geographical barriers. As a result, the WebCT platform eases the task of lecturers to deliver and maintain learning material. Due to diverse learner populations and a high priority on learner performance, it becomes increasingly important to provide flexible, personalized learning experiences that meet a diverse range of learning needs. WebCT does not restrict lecturers to a particular type of curriculum/programme design or delivery model. WebCT supplies the flexibility to design and deliver programmes in a way that best fit the teaching styles of lecturers and their learners’ needs (WebCT, 2003:4).

Lecturers and tutors can access WebCT and create online programme
content, assess learner test results, post announcements and upload materials, to name but a few. WebCT also provides the lecturer with the ability to generate tests using test-question banks and question randomisation. The questions can be randomised so that their order of presentation change each time learners activate an online test. The test delivery feature allows the lecturer to release a test on a specific date and time and for a limited period of time. Information feedback on tests can range from full feedback e.g. test questions, learner responses, correct answers and the final score, to no information being released.

A logon account for each learner was created from the DOS1 roster that was downloaded from the university’s Online Personal Access (OPA) system. It was then uploaded to the WebCT database. Learners could access programme material on WebCT only if they had an account. According to Kilby (2005), controllable access is a major advantage of CBT.

WebCT furthermore supports highly individualized learning, just-in-time remediation, learner-centered education and active learning. The WebCT environment provides learners with programme content, and the developers with a framework for authoring, managing, monitoring and evaluating CBT material (Blank et al., 2002b). It also allows for easier updating of programme content in the future (Kilby, 2005). According to Goldberg and Salari (1997a, 1997b), WebCT facilitates the creation of sophisticated Web-based educational environments. Horton (2000) states that WebCT provides a suite of simple tools to administer a programme, deliver instruction, and facilitate online learner interaction.

Morss (1999:394) further states that WebCT provides course management
tools for grading, tracking learner interaction and monitoring class progress. WebCT also has the capacity to facilitate the creation of sophisticated WWW-based education environments by non-technical users. WebCT enables the creation of entire online programmes, or the publication of material that supplement existing programmes.

Delport (2003) cites Britain and Liber⁷ who state that web-supported learning using WebCT, provides a learning environment that is conducive to learning as it offers benefits that concurred with the recommendations of the Dearing report⁸. These benefits include:

- Flexibility of time and place.
- Coping with increased learner numbers.
- Sharing and re-use of resources.
- Collaborative work.
- Learner-centered learning.
- Reducing administration burden.

According to Basson (2002:62), the importance and convenience of delivering programme content on WebCT, gives universities a competitive edge among those that offer online WBT. The overall result of delivering the CBT module for the purpose of this thesis via the WebCT platform, was quick download times, flexible and interactive access, as well as control of the learning material.

3.10 THE CBT MODULE

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Educational multimedia created in the Microsoft PowerPoint and Macromedia Flash environments differs from that created using Web-based instruction.

Despite these differences it is assumed for the purpose of this research, that the use of colour, typography, layout, and screen density have the same effect on the visual design of the instruction material regardless of how, and with which software tool the content was developed.

Once the learner has selected the appropriate programme (DOS1) in WebCT, the CBT module, programme information and the author’s details are available to the learner. If learners called for any application-related questions, they could either e-mail the author or post it on the WebCT bulletin board. Some students preferred to meet the author face-to-face. Effective online education CBT modules should incorporate ways to facilitate communication and interaction where appropriate, a fact which is supported by Beckstrand (2002) and Cooper (2000). Learners must also be able to communicate with the lecturer and receive timely support when faced with problems or have questions. Furthermore, learners need to be able to interact with one another (Cooper, 2000:21-22).

The main design principle of this research is based on the notion that the interface has to be subjectively useful and acceptable to the learners. As a result, learners had to perceive benefit from the interface, feel empowered by it, and enjoy using it. Multimedia applications should be enjoyable to use and should be aesthetically pleasing to the learner (Lindgaard, 1994). The module was designed and developed to maintain a trouble-free, reliable and intuitive look and feel. The most time-consuming and challenging part of this research was the design and development of the CBT module.

Four guidelines were followed during the design of the module based upon
guidelines used by Beckstrand (2002:54-55), namely availability, ease of use, similarity of module delivery methods, and timeliness of module delivery. These elements are briefly discussed below:

- **Availability:** The CBT module has to be available at any time and any place.

- **Ease of use:** This means that only a minimum number of actions have to be taken in order to allow a learner to start, stop and move between screens in the module.

- **Similarity of module delivery methods:** The CBT module has to map traditional lecture instruction delivery of the module.

- **Timeliness of module delivery:** The delivery method should not require learners to download a large amount of material before the module can be used. This will ensure that Internet access cost is kept to a minimum. Computer systems should only have to use a minimal number of resources in order to process and present any given instructional module.

Several software packages were used to develop the CBT module, namely Microsoft PowerPoint (to develop the first CBT module), Macromedia Flash (to develop the final prototype CBT module), WebCT (to deliver the module on the Internet and to produce test offerings), Paintshop Pro (to create and edit images), as well as Microsoft Word XP and Adobe Acrobat 7 (to produce lecture notes).

The learning objectives for the CBT module were clearly stated at the start...
of the module to inform learners on the degree of understanding they have to achieve. The CBT module was presented over five lessons. Lessons were broken down into a total of 27 screens. The module contained text, colourful graphics (moving and static), animation and audio. According to Nielsen (1995:4-5), audio can provide a path that is separate from that of the display. Nielsen (1995) further states that speech can be used to offer explanations or help without diminishing the information on the screen.

While some screens are entirely text-based, some are text-based with diagrams or graphics, and others contain animation to aid learner understanding, information retention, and to highlight important concepts. Difficulty was encountered in the development of the CBT module - balancing the needs of the user interface such as not cluttering screens versus the amount of content and additional explanations needed. The CBT module was designed and developed to be used in conjunction with textbooks, lecture notes (De la Harpe, 2003) and lectures, and represents a summarized version of the programme materials.

The CBT module consists of two introduction screens that inform the learner how to operate the module, two information screens that supply the learner with the module content and training objectives, and five lessons (27 screens) that cover different topics of the subject curriculum. Although the module content had been obtained from books and lecture notes (Appendix E), CBT is rated more highly than textbooks (Sneiderman, Hood & Patterson, 1994). Some developers map the content material in the same way as it appears in the textbook. This limited approach is highly unproductive, and very little is gained by transferring the material from paper to electronic format (Pham, 1998). The content validity of this module was established by the programme coordinator who at the time was also a lecturer for the DOS1 subject.

The screen size is optimized to an 800 by 600 pixels screen resolution that
allows full screen display without the need for scrolling. The two most
important components of the module are the graphic interface and the
navigational system. In this research the CBT module enables learners to
select a topic of choice, move between screens, and exit the module at
any given time. This approach is known as “nonlinear access” and gives
learners the freedom to proceed at their own pace (Koehn, 1995).

Each screen of the CBT module is divided into two parts (Figure 3-4). The
left side of the screen is mostly used to explain the topic, whereas the right
side of the screen is mostly used to supply information of importance
(except for the introduction screens). Each introductory screen contains
an option to either enable or disable sound. Sound can also be
manipulated by gradually increasing or decreasing the volume. Each
screen also contains a grey banner at the top that informs the learner of
the lesson’s title, or supplies information on the learner’s progress through
the module. The red banner at the bottom of each screen informs the
learner of the module’s title. Screens are consistent in their appearance
by using the same colours, font styles, font sizes, and screen layout. To
increase the readability of the module’s content, the module was limited to
no more than two or three different font styles or font sizes on each
screen.

According to Clemenz, Weaver and Gore (2000), visual interest and
readability are enhanced by highlighting text, using titles and headings,
and the use of upper- and lowercase text. In the CBT module colour is
used to highlight important content, whereas graphics are used throughout
the module to create a user-friendly visual environment. Text that must be
read should have high contrast, while font sizes must be large enough to
be easily readable on standard computer monitors (Tognazzini, 2003).

There are three fundamental aspects for developing a user-friendly CBT
module namely visualization, interactivity, and navigation (Klett, 2002:42). Learning material needs to be user-friendly for both content and navigation (Sherson, 1999:5). According to Downes (1996), if learners are lost or have to spend time thinking about where to go next, they cannot focus on the learning material. The main benefit of animation is to attract learner attention (Clemenz et al., 2000). However, this was used sparingly in the CBT module in order not to distract the learner.

Navigation buttons appear in the right bottom corner of each screen. The learner can exit from the module at any given time by clicking on the “Stop” button, which will display the “Quit” screen (Figure 3-4). The introduction of the CBT module orientates the learners and graphically explains the navigation functions (Figure 3-5).

![Figure 3-4: The quit screen](image-url)
Figure 3-5: The module introduction screen

The next few screens outline the content (Figure 3-6) and objectives to be covered in the CBT module (Figure 3-7).
Figure 3-6: The module content screen

Figure 3-7: The module objectives screen
After the introduction, self-directed learning is achieved by using a WebCT menu from where learners can choose the lesson they elect to complete, and how often they wish to repeat it (Figure 3-8). The learner has total control over the movement around the various topics/lessons.

![Figure 3-8: WebCT main menu with lesson topics](Image)

Each lesson starts with a loading screen (Figure 3-9) that is followed by a title page (Figure 3-10). Each lesson guides the learner through different topics (Figure 3-11). Information presented in the module was equivalent in content with those of learners attending classroom-based lectures.
Figure 3-9: The loading screen

Figure 3-10: The title page screen
It is of importance to note that the effectiveness of CBT material is dependent on its integration into the programme, the supporting material used, whether its use is mandatory or optional, and the times it is made available (Frith, 1997a).

Learners can do self-evaluation at any time throughout the CBT module. Self-evaluation is facilitated by means of a set of review questions developed in Microsoft PowerPoint (Figure 3-12). Learners can complete review questions when they feel comfortable with the module content. The review questions provide informative and positive feedback to help develop self-esteem and promote a sense of achievement in the learner. These questions are aimed at helping learners to monitor their level of understanding.
3.11 PRE- AND POST-TESTS

Pre- and post-testing of learners was accepted as a viable method to assess the extent to which an educational intervention has impacted upon learning. Since learners with different skills and backgrounds study a particular subject, it is important to establish the baseline knowledge of the learners on topics discussed in the classroom. Baseline knowledge is obtained to measure the degree of any changes in the knowledge or understanding at the end of a particular period of learning (Harvey, 1998:146-149). Ramsey (1996) refers to baseline knowledge as “original learning”. Original learning is measured by means of a test administered at the completion of an instruction. This measure allows for a comparison of instructional methods immediately following the instruction (Ramsey, 1996:13-14).
Tests are completed by the learner both before and after they use the CBT material to determine if there is a change in learner performance on such tests (Jones, Scanlon, Tosunoglu, Ross, Butcher, Murphy & Greenberg, 1996). Pre- and post-tests were therefore used in this research to provide an assessment of learners’ understanding of the programming language. Furthermore, it was used to determine whether the educational intervention had a positive impact on learner performance, and to quantify the impact thereof. The process comprises two steps. Firstly, learners have to complete a test (pre-test) to determine their level of knowledge or understanding of a specific topic. During a later stage, learners had to complete a comparative test (post-test) to determine the extent to which knowledge and understanding has been improved by the educational intervention. According to Harvey (1998:46), the pre-test must be given to learners only after they have acquired the relevant knowledge of the specific CBT module content.

Pre- and post-testing should be viewed as resources that enable lecturers to learn more about how learners engage in CBT rather than as a means of demonstrating changes in knowledge or skills. This can be achieved by using appropriately designed pre- and post tests. This method can determine whether the delivery mode of instruction has caused a change in learner responses (Harvey, 1998:47). In this research the post-test was given to learners immediately after they had completed their study of the CBT module. In the post-test, a proportion of the pre-test was retained and juxtaposed with new questions which examined the same expected learning outcomes. This approach ensured that there was no threat to the internal validity of the results.

Validity refers to the extent to which an instrument measures what it is supposed to measure (Tucker, 2001; Vivekananda-Schmidt et al., 2004:51). It refers to the testing of the relationship of a given measure to some standard measure of success (Tucker, 2001) e.g. comparing CBT
results to that of traditional instruction results. While online tests are labour intensive, it provides a great deal of useful information on how learners learn (Harvey, 1998:49). Another major benefit, from a lecturer’s point of view, is that it nullifies the time-consuming process of manually grading each test.

3.11.1 Pre- and post-testing procedure

In this research, an experimental pre-test/post-test approach was used to evaluate whether learners performed better when using the CBT module as opposed to attending traditional classroom-based instruction.

Learners were divided into two groups (Paragraph 3.5). Groups, rather than individuals, were randomised into a control group (who received traditional classroom instruction) and experimental group (who received CBT instruction). Due to the fact that groups were randomly assigned to either a control group or experimental group, most internal threats to validity were controlled. The pre-test verifies whether both groups have more or less the same knowledge. Both groups were advised that a pre-test would be undertaken prior to using the CBT module or attending lectures, and a post-test two weeks after commencement of the study period. The pre-test assisted in giving an indication of the learners’ pre-CBT module knowledge, and to illustrate the type of questions the learner would need to answer in the post-test. After completion of the pre- and post-tests, learners could view their test questions, answers and scores. Online testing is useful when quick return on formative feedback is required (Smit, s.a.). All learners were informed that these tests would not count towards their final year mark.

Learners in the experimental group could use the CBT module in conjunction with any current learning resources to study for the post-test. Because the intention was that the CBT module would be evaluated for its
educational effectiveness when integrated with current resources, and not as a substitute, each learner was given the learning objectives and lecture notes. Learners in the control group received the same information as the CBT group, and both groups had the same learning objectives.

Both groups completed the same pre-test and post-test. Following the pre-test, the experimental group completed the CBT module, whereas the control group attended traditional classroom-based lectures. Cognitive gains (performance) of learners were measured by comparing the pre-test and post-test results. The gain is the difference between pre-test and post-test scores.

3.11.1.1 Pre-test

Each test consists of 25 multiple-choice questions, with questions presented in a random fashion to each learner (Appendix B). Multiple-choice questions are viewed as the most objective and therefore the most popular type of questions for learner assessment (Simpson, 2001:6). In WebCT test questions can be displayed in a randomised order when the test is presented. This ensures that test questions appear in a different order for each learner.

Explanatory feedback was provided for correct and incorrect responses. Semi-intelligent error feedback (the learner is given feedback on which answers are correct or incorrect on a multiple-choice test) gave additional information for remediation of incorrect answers. This allowed the learner to move on to the next learning task without the textbook or other programme materials to correct their mistake (Stansfield et al., 2004). It would be ideal if the pre-test results of both groups would be similar. This would prove that the two groups had relatively the same knowledge or background about the factors that affect their performance (Balasubramanian, 2002).
The online multiple-choice pre-test was completed by 206 learners in a 30 minute session on WebCT. Learners completed the pre-test without any assistance. An advantage of using the WebCT platform is that it keeps record of learners’ answers to questions. Questions can be analysed rapidly to provide the lecturer with immediate results and feedback about learner performance. Self-assessment and immediate, guiding feedback is an important aid to successful learning (Gardner et al., 2002:128). The pre-test was given to learners to evaluate their knowledge prior to additional CBT or classroom-based instruction.

3.11.1.2 Post-test

One and a half weeks after instruction (whether it was by means of traditional instruction or CBT), both groups were scheduled for completion of the post-test. The post-test (Appendix C) was conducted in the same manner as the pre-test, and completed using the same group of learners as with the pre-test.

3.11.2 Pre- and post-test feedback

Learner responses on the two tests were stored in the WebCT database. WebCT performs an item analysis on each question separately and gives an average score for the whole group. This function enables the lecturer (and learner) to obtain instant feedback on learner performance. Online tests allow for assessing learner progress as well as providing feedback to learners. Both the pre- and post-tests support feedback, which enables the learner to learn whether or not they know the answer. This enables the learner to get a better understanding of the thought process involved in solving problems (Blank, Kay, Pottenger, Heigl, Roy & Sahasrabudhe, 2002a). Feedback on learner performance is a multimedia CBT application’s most powerful form of guidance (Carr, 2002:7).
If a field trial method is not designed with care, it could result in difficulty to interpret the data. The reason for this is that improvement in performing a task could result from factors such as sensitization to the area due to pre-testing or intuition rather than training alone (Goldstein, 1993). Similar to research conducted by Balasubramanian (2002:39), both groups completed the same pre-test and post-test, and as a result, sensitization was equal in both groups. This in turn equally impacted upon the data from the post-test of both groups.

3.12 QUESTIONNAIRE

Gunawardena, Lowe and Carabajal (2000) point out that the methods used most often to assess learner attitudes to, and satisfaction with a module include online questionnaires, paper and pencil surveys and electronic feedback (e.g. e-mail). Additional and richer data can be obtained by using items such as open-ended questions. Questionnaires can help to overcome the shortcomings of relying on test results alone. Löwgren (1993:57) agrees with Gunawardena et al. (2000) and suggests that the most obvious techniques to gather subjective evaluations of learner attitudes are interviews and questionnaires.

The traditional method of pre- and post-tests should also be used to measure learning. The combination of these two methods can indicate if significant learning has occurred. One shortcoming of this type of analysis is, however, its inability to explain why any significant learning has occurred (Gunawardena et al., 2000). In this research, the problem was solved by supporting a mixed-methodology approach that combines objective data, such as pre- and post-tests, as well as subjective data obtained by means of a questionnaire. Beckstrand (2002:44) supports this mixed-methodology approach and suggests that in order to evaluate a module not only objective data (pre-test, post-test and demographic information) should be used, but subjective data (attitudes towards
technology and the module) must also be gathered. Malone, Malm, Nay, Oliver, Saunders and Thompson (1997) are also of the opinion that evaluation of instructional effectiveness must consider an assessment of learner attitudes towards the learning delivery application.

Immediately after completion of the CBT module, a formative approach was followed by gathering information by means of an online questionnaire (Appendix D). The questionnaire was completed by the experimental group directly after they have finished the post-test. If class time is set aside for completion of a questionnaire, it is more likely to be completed (Harvey, 1998:13). The questionnaire design included an explanation on the purpose of the questionnaire, instructions on how to complete it and a thank you note at the end.

3.12.1 Questionnaire procedure

A questionnaire is the most convenient way to collect information. Directly after completion of the post-test, the experimental group filled out an anonymous online questionnaire to evaluate the module and their attitude towards it. Barnes (1999) states that learners are more comfortable when they can anonymously communicate with lecturers. Due to privacy and ethics concerns, the learners’ anonymity was assured. Even though an anonymous questionnaire places limits on a follow-up research with individuals, it is still possible to monitor class trends (Harvey, 1998:50). Many learner views can be collected at once, and significantly comparative measurements can be made (Frith, 1997a).

Learner attitudes towards study and technology will influence their goals and learning outcomes (Prosser & Trigwell, 1999). Attitude will also influence how a learner reacts to the application and associated technology (Robson, 2000:167). The formative evaluation method evaluates the reaction to and satisfaction of learners with the CBT module.
Learner opinions are of great importance when deciding whether a particular approach will be continued for future instruction.

The questionnaire consisted of 55 questions and took learners approximately 15 minutes to complete. Questions were simple, unambiguous and had a consistent style (multiple-choice and open-ended questions). Each question addressed a feature of the CBT module or a broader aspect of the module’s use. Questions were formulated as to evaluate different aspects of usability, appearance of screens, general impressions with CBT module, learner attitude, general experience, satisfaction with CBT module, and the impact CBT had on their learning process.

After completing demographic questions (e.g. age, gender, programme enrolled for, language preference, previous use of CBT, previous computer experience etc.), learners had to indicate their agreement/disagreement with each question based on a 5-point Likert scale (1 = strongly agree, 5 = strongly disagree). The Likert style type questions were used to collect learner satisfaction rating scores. Several open-ended questions were included in the questionnaire to allow learners to provide personal feedback on the CBT module. Responses to open-ended questions can be useful to ascertain what issues they consider of importance (Harvey, 1998:50).

3.13 SUMMARY

In this chapter, the design, development, and evaluation of an interactive CBT module, as well as the methods used to collect data, were discussed. Furthermore, this chapter dealt with an outline of the research methodology and the design of the pre- and post-tests and questionnaire. In addition, the software tools used in this research were outlined.
CHAPTER 4

DATA ANALYSIS, RESULTS AND INTERPRETATION

4.1 INTRODUCTION

This chapter describes the data obtained, statistical analysis, and research outcomes of the research. It presents and analyses the data collected using the methods described in Chapter 3. It also describes the statistical process including the statistical tests used, the level of significance and calculated differences, and the interpretation of results of the statistical tests. The results of all the tests are used to determine the statistical likelihood of any significant differences that exist in learner perceptions of CBT in the DOS1 subject.

The empirical section of this research was conducted over a six-week period during 2004. Learners had either to work through an online CBT module, or attend traditional classroom instruction. Learners were randomly assigned to either a control group (traditional instruction) or experimental group (CBT instruction). All learners completed a pre-test prior to receiving instruction. After instruction, learners had to complete a post-test to determine their gain scores. The experimental group who made use of the CBT module also filled out a questionnaire to determine their overall attitude towards the module.
4.2 DATA ANALYSIS AND RESULTS

4.2.1 Pre- and post-tests

The analysis of the pre-test scores indicated that the experimental group (CBT instruction) and control group (traditional instruction) had comparable knowledge levels (Appendix A).

Tables 4-1 and 4-2 show that the mean pre-test score for the control group (classroom-based instruction) was 12.94 out of a possible 25 (SD=3.31). The five-number summary (Graph 4-1 – Graph 4-3) is used to illustrate the median (mid-point of the data set), four quartiles, and the smallest and greatest values in the pre- and post-test distributions. This data plot is useful when two or more data sets are being compared. Graph 4-1 illustrates that the control group had a median of 52% for the pre-test. The range of percentages was large (28% to 92%). The highest percentage (92% for learner 57) was indicated as an outlier, because this one piece of data fell well outside the range of the other values. The distribution was slightly skewed. The lower quartile was 44%, the upper quartile 60%, and the interquartile range (the difference between the upper and lower quartile) was 16%. The mean post-test score (out of 25) for the control group was 16.54 (SD=3.78) with a wider range of percentages (16% to 96%). The range of percentages was large at 80%, due to the lowest score (16% for learner 27) that was indicated as an outlier (Graph 4-2). The distribution was slightly skewed. The lower quartile was 56%, the upper quartile 76%, and the interquartile range was 20%. The control group had a higher median (68%) for the post-test than in the pre-test (52%). The average percentage achieved by learners in the control group for the pre-test was 52%, and 66% for the post-test.
The mean pre-test score (out of 25) for the experimental group (CBT instruction) was 12.88 (SD=3.51). The experimental group had a median of 48% (Graph 4-1). The range of percentages was large (24% to 92%). No outliers were found for the experimental group. The distribution of percentages for the pre-test was slightly skewed. The interquartile was 24% (upper quartile = 64%, lower quartile = 40%). The mean post-test score (out of 25) for the experimental group was 16.51 (SD=3.34) with a narrower range of percentages (28% to 92%). No outliers were found for the experimental group (Graph 4-2). The distribution of percentages for the pre-test was slightly skewed. The interquartile range was 20% (upper quartile = 76%, lower quartile = 56%). The experimental group also had a higher median (68%) in the post-test than in the pre-test (48%) (Graph 4-2). The average percentage achieved by learners in the experimental group for the pre-test, was remarkably the same as the control group (52%). The same results were found for the post-test, where learners achieved an average percentage of 66% for the post-test.
Graph 4-1: Comparison of pre-test percentages between control and experimental groups
Graph 4-2: Comparison of post-test percentages between control and experimental groups

The mean gain score (all out of a possible 25) for the control group was 3.60 (SD=4.23), and the mean gain score for the experimental group was 3.63 (SD=3.91). Learners in both the control and experimental groups thus showed an improvement of 14%.

Both the control and experimental groups had a median of 16% for gain percentages (Graph 4-3). The range of percentages for the control group was large (96%) due to a minimum outlier of -28% (for learner 27) and a maximum outlier of 68% (for learner 89). This means that learner 27
performed 28% worse in the post-test than in the pre-test, and learner 89 performed 68% better in the post-test. The interquartile range was 20%. Similar results were found in the experimental group. The range of percentages was large at 92%, due to a minimum outlier of -40% (for learner 200). Learner 200 thus performed 40% worse in the post-test than in the pre-test. The interquartile range (20%) for the experimental group was the same as that of the control group.

Graph 4-3: Comparison of gain percentages between control and experimental groups
Table 4-1: Pre-test and post-test data from summative evaluation (score out of 25)

<table>
<thead>
<tr>
<th>Number of learners</th>
<th>Pre-test score Mean (SD)</th>
<th>Post-test score Mean (SD)</th>
<th>Gain score (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>112</td>
<td>12.94(3.31)</td>
<td>16.54(3.78)</td>
</tr>
<tr>
<td>Experimental group</td>
<td>94</td>
<td>12.88(3.51)</td>
<td>16.51(3.34)</td>
</tr>
</tbody>
</table>

Table 4-2: Descriptive statistics for control and experimental groups (percentages)

<table>
<thead>
<tr>
<th></th>
<th>Pre-test score (%)</th>
<th>Post-test score (%)</th>
<th>Gain score (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group</td>
<td>Experimental group</td>
<td>Control group</td>
</tr>
<tr>
<td>Mean</td>
<td>51.75</td>
<td>51.53</td>
<td>66.14</td>
</tr>
<tr>
<td>SD</td>
<td>13.25</td>
<td>14.03</td>
<td>15.12</td>
</tr>
<tr>
<td>Mode</td>
<td>44</td>
<td>48</td>
<td>76</td>
</tr>
<tr>
<td>Median</td>
<td>52</td>
<td>48</td>
<td>68</td>
</tr>
<tr>
<td>Highest score</td>
<td>92</td>
<td>92</td>
<td>96</td>
</tr>
<tr>
<td>Lowest score</td>
<td>28</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>Pass (%)</td>
<td>52%</td>
<td>49%</td>
<td>84%</td>
</tr>
</tbody>
</table>

Pre-test and post-test scores for both groups are illustrated and summarized in Graphs 4-4 and 4-5. Graph 4-6 illustrates the gain scores for both groups.
Graph 4-4: Pre-test vs. post-test scores (control group)

Graph 4-5: Pre-test vs. post-test scores (experimental group)
Graph 4-6: Gain score comparison between control and experimental groups

T-tests were used to determine whether the CBT module was effective as an instructional tool. T-tests were computed to determine if there was a statistical significance between the means scores of the two groups. Independent t-test results indicated $t(204) = 0.115$, $p = 0.909$ for a two-tailed $\alpha = 0.05$. The $p$ value of 0.909 indicates that there were no significant differences between the two groups' pre-test scores. A paired t-test was performed within each group between the pre-test and post-test to determine if any learning did occur. Results for the control group indicated $t(11) = 8.996$, $p = 7.277$ for a two-tailed $\alpha = 0.05$. These results indicated no significant difference at $\alpha = 0.05$ for the control group, that confirms that there was no significant difference in scores obtained in the pre-test and post-test. As with the control group, t-test results within the experimental group indicated for a two-tailed $\alpha = 0.05$, $t(93) = 9.001$, $p = 2.656$. These results ($p > 0.05$) showed no significant difference at $\alpha = 0.05$ for the experimental group, that confirms that there was not a significant difference in scores obtained in the pre-test and post-test.
To determine whether there was a significant difference in gain scores between both groups, another t-test was performed. The p result of 0.959 that indicates that there was no significant difference between the gains for both groups, supports the null hypothesis (Paragraph 1.4). The 0.12% gain ascertained that CBT instruction was equivalent to or at least as effective as classroom-based instruction for training DOS1 learners. Gain scores between the control group and experimental group did not indicate any significant improvement. Both groups showed a positive gain, but with an insignificant difference between pre-test and post-test results within each group.

Table 4-3 shows a comparison of the control and experimental group means in the pre-test and post-test (25 questions each) scores.

Table 4-3: Comparison of control and experimental group means in the pre- and post-tests

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of learners</td>
<td>112</td>
<td>94</td>
</tr>
<tr>
<td>Average number of correct answers per learner</td>
<td>7.89 (32%)</td>
<td>7.66 (31%)</td>
</tr>
<tr>
<td>Average number of incorrect answers per learner</td>
<td>17.11 (68%)</td>
<td>17.34 (69%)</td>
</tr>
<tr>
<td>Ratio of correct answers to incorrect answers</td>
<td>884:1916</td>
<td>720:1630</td>
</tr>
<tr>
<td><strong>Post-test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of learners</td>
<td>112</td>
<td>94</td>
</tr>
<tr>
<td>Average number of correct answers per learner</td>
<td>10.90 (44%)</td>
<td>11.06 (44%)</td>
</tr>
<tr>
<td>Average number of incorrect answers per learner</td>
<td>14.10 (56%)</td>
<td>13.94 (56%)</td>
</tr>
<tr>
<td>Ratio of correct answers to incorrect answers</td>
<td>1221:1579</td>
<td>1040:1310</td>
</tr>
</tbody>
</table>
4.2.2 Questionnaire

Analysing latent constructs such as learner satisfaction, requires instruments to accurately measure the constructs. Cronbach’s coefficient alpha (α) was used in this research to estimate the reliability of this type of scale by determining the internal consistency of the correlation of items within the questionnaire. These results are discussed in more detail in Paragraphs 4.2.2.1 – 4.2.2.5. Six variables were created for Likert scale items within the questionnaire (Table 4-4). A principal components analysis for categorical data shows the correlation between variables, and is depicted in Table 4-5.

Table 4-4: Six variables created for items within the questionnaire

<table>
<thead>
<tr>
<th>D</th>
<th>= Demographics</th>
<th>I</th>
<th>= Interface</th>
<th>A</th>
<th>= Attitude</th>
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<tbody>
<tr>
<td>U</td>
<td>= Usability</td>
<td>C</td>
<td>= Content</td>
<td>PP</td>
<td>= Pre- and post-tests</td>
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</tbody>
</table>

Table 4-5: Correlation between variables

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</tr>
<tr>
<td></td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.211*</td>
<td>.154</td>
<td>.215*</td>
<td>-.109</td>
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<tr>
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<td>Sig. (2-tailed)</td>
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<td>.041</td>
<td>.138</td>
<td>.037</td>
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<td>.805**</td>
<td>.444**</td>
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<td>Sig. (2-tailed)</td>
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<td></td>
<td>.000</td>
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<td>I</td>
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<td>Pearson Correlation</td>
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<td>.487**</td>
<td>.568**</td>
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<td></td>
<td>Pearson Correlation</td>
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<td>Sig. (2-tailed)</td>
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<td>.072</td>
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</table>

* Correlation is significant at the 0.05 level (2-tailed) (p < 0.05)

** Correlation is significant at the 0.01 level (2-tailed) (p < 0.01)
The correlation between the demographics (D) and usability (U) variables was significant at the 0.05 level ($p < 0.05$). The $p$ value of 0.041 indicated a positive significant correlation. The correlation between the demographics (D) and interface (I) variables indicated an insignificant correlation ($p = 0.138$) at the 0.05 level. Furthermore, the correlation between the demographics (D) and content (C) variables proved to be significant at the 0.05 level ($p = 0.037$). An insignificant correlation ($p = 0.297$) was found between the demographics (D) and attitude (A) variables. The $p$ value of 0.072 for the demographics (D) and pre- and post-test (PP) variables also showed an insignificant correlation ($p > 0.05$).

The correlation between the usability (U) and interface (I), content (C), attitude (A) and pre- and post-test (PP) variables was significant in all cases. The $p$ value of 0.000 indicated a positive significant correlation ($p < 0.05$). The same results were found between the interface (I), and content (C) and attitude (A) variables. Furthermore, a positive significant correlation ($p = 0.001$) was found between the interface (I) and pre- and post-test (PP) variables, as well as between the content (C), and attitude (A) and pre- and post-test (PP) variables ($p = 0.000$). The correlation between the attitude (A) and pre- and post-test (PP) variables also proved to be significant at the 0.05 level ($p = 0.001$).

### 4.2.2.1 Demographic information

Only the experimental group ($n = 94$), who made use of the CBT module, completed the questionnaire. The learners had different backgrounds, e.g. gender, the type of programme enrolled for, age group, home language, the number of years using a computer, as well as previous experience with computers and CBT material. The gender demographics of the learners consisted of 58 (62%) males and 36 (38%) females (Graph 4-7). The gender demographics for the control group were 61 (54%) males and 51 (46%) females. Blank et al. (2002b) state that
demographics appear to imply that multimedia CBT can have a significant impact on learner achievement when learning programming. As there was no control of gender or age across the control and experimental group, it was not feasible to study the influence of these variables on the delivery outcomes.

**Graph 4-7: Proportion of males and females who completed the questionnaire (Q2)**

Learners who completed the questionnaire were enrolled in either the Information Technology (IT) programme (70%) or the Financial Information Systems (FIS) programme (30%) - (Graph 4-8).

---

9 “Q” refers to question.
The majority of learners’ ages ranged between 18 and 24 years. Only six learners were younger than eighteen years. Five learners indicated that they are older than twenty-four years (Graph 4-9).
Even though the module was only available in English, learners from several language backgrounds (Graph 4-10) have shown a positive gain in their performance. This was a positive indication towards the value and impact of using CBT material in the DOS1 subject. Many learners found it difficult to verbalise their understanding of the work and as a result resorted to rote studying. Learners thus memorized their work instead of understanding it (Venter et al., 2001). The author of this research endeavoured to minimize this potential problem by presenting information in a more visual format and by means of animation. The majority of learners were Xhosa speaking (35%), which was followed by 29% Afrikaans and 24% English learners. The rest of the learners made up the remaining 12%.

![Graph 4-10: Proportional distribution of learners' language preference (Q4)](image)

The majority of learners (47 learners = 50%) indicated that they had more than three year’s computer experience (Graph 4-11). Only 14 learners (15%) indicated that they had one to three year’s experience, followed by 19 learners (20%) with between six and eleven months experience. The rest of the learners (14 learners = 15%) indicated that they had less than six months computer experience.
Learners had to indicate whether they were confident to work with everyday computer applications. Results show that 79% of the learners were confident and only 9% were not confident to use computer applications on a daily basis. Eleven learners (12%) indicated that they were uncertain (Graph 4-12).

Graph 4-11: Timeframe for learner computer use (Q5)

Graph 4-12: Proportion of learners feeling confident to work with everyday computer applications (Q6)
Furthermore, 54% of the learners indicated that they had access to a computer at home (Graph 4-13). It was observed that for most of the learners in the experimental group, it was their first attempt at a non-traditional mode of study. Ninety-seven percent of the learners have not used a CBT module in the past (Graph 4-14).

Graph 4-13: Proportion of learners that have a PC at home (Q7)

Graph 4-14: Proportion of learners that used CBT material in the past (Q8)
Results obtained from the questionnaire indicated that the learners showed a general sense of satisfaction, as the CBT module was perceived to be useful, easy to use, flexible and stimulating. The majority of learners claimed that they learned from the module and that it improved their understanding of the subject content. The majority of learners also indicated that they prefer to use similar modules more frequently in the future. Regarding the structure of the module, most responses proved to be very favourable.

Results from the questionnaire returned the same results as a survey conducted by Rainbow and Sadler-Smith (2003:615). Results returned that learners showed a positive disposition towards CBT irrespective of their gender, age or educational background.

The reliability was shown to be high for the demographics (D) variable (Questions 1 – 8). The reliability coefficient (α) of 0.767 indicated that the items (Questions 1 – 8) contributed to a reliable scale, and could therefore be viewed as an acceptable reliability coefficient. A reliability coefficient of 0.70 or higher is considered as acceptable.

4.2.2.2 Interface and usability of the CBT module

Table 4-6 and Graph 4-15 show that the interface encouraged learners to use the module. Graph 4-15 (Q9) indicates that the majority of the learners in the experimental group either strongly agreed (11 learners = 12%) or agreed (38 learners = 40%) that the module had a pleasant interface. Only four learners (4%) strongly disagreed that the interface was not as pleasant, whereas ten of the learners (11%) disagreed.

Graph 4-15 (Q10) shows more or less the same trend towards the encouragement of the module as that of the “pleasantness” of the module. A total of 13 learners either strongly agreed (14%) or agreed (40 learners
that the module had been encouraging to use. Only three learners (3%) strongly disagreed that the module encouraged them to use it, and nine learners (10%) disagreed. In Graph 4-15 (Q11) results show that the screen layout of the module proved to be clear to learners. Most of the learners either strongly agreed (17 learners = 18%) or agreed (58 learners = 62%) that the module’s screen layout is clear. Only two learners (2%) strongly disagreed that the screen layout of the module was not clear, and six learners (6%) disagreed.

Table 4-6: CBT module evaluation tabulation on usability and looks of CBT module (Q9 - Q11)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q 9</td>
<td>11</td>
<td>38</td>
<td>31</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Q10</td>
<td>13</td>
<td>40</td>
<td>29</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Q11</td>
<td>17</td>
<td>58</td>
<td>11</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Graph 4-15: Evaluation results for usability and looks of CBT module (Q9 - Q11)
In addition Table 4-7 and Graph 4-16 (Q12) also indicate that the majority of the learners in the experimental group either strongly agreed (18 learners = 19%) or agreed (54 learners = 57%) that the colours used in the module enhanced their learning experience. Only two learners (2%) strongly disagreed that the colours used in the module enhanced their learning experience, and five of the learners (5%) disagreed.

According to Question 13, the agreement on the colour balance of the module showed the second highest percentage regarding the usability and interface aspects (Graph 4-16). Sixteen (19%) of the learners strongly agreed that the colour balance was satisfactory, and 59 learners (63%) indicated that they agree. Only one learner (1%) strongly disagreed and found the colour balance not to be satisfactory. Six learners (6%) disagreed. In Graph 4-16 (Q14) the graph shows that most of the learners strongly agreed (18 = 19%) or agreed (56 = 60%) that the content material in the module was presented in a creative way. Results indicate that two learners (2%) strongly disagree with this statement, whereas none of the learners (0%) disagreed.

Table 4-7: CBT module evaluation tabulation on usability and looks of CBT module (Q12 - Q14)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q12</td>
<td>18</td>
<td>54</td>
<td>15</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Q13</td>
<td>16</td>
<td>59</td>
<td>12</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Q14</td>
<td>18</td>
<td>56</td>
<td>18</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 4-8 (Q15) lists some of the comments from learners on the general appearance of the CBT module’s interface (learner comments were not edited). A small portion of the learners did not provide any comments. Learners indicated an overall positive attitude towards the interface (usability and looks) of the CBT module. Learners were pleased with the general appearance of the module. They found the module to be colourful and fun to use. The use of colour is a very important aspect of CBT material, generally making material more attractive and interesting to work with. Furthermore, the majority of learners indicated that the module “looks great” and that it was understandable.
Table 4-8: Learners’ positive comments on the general appearance of the CBT module’s interface (Q15)

<table>
<thead>
<tr>
<th>QUITE CLEAR AND UNDERSTANDABLE</th>
<th>The General appearance is Ok, it makes this module look interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is creative</td>
<td></td>
</tr>
<tr>
<td>It was an okay module to work with, although its very new. I think I just need to adapt to the work, but it was an unforgettable experience that's for sure</td>
<td></td>
</tr>
<tr>
<td>As a first time user, i quite enjoy the experience</td>
<td></td>
</tr>
<tr>
<td>Its ok the way it is</td>
<td></td>
</tr>
<tr>
<td>Very colourful and pleasing to log in to</td>
<td></td>
</tr>
<tr>
<td>It was pleasant</td>
<td></td>
</tr>
<tr>
<td>IT WAS VERY INTERESTING, I LIKED IT</td>
<td></td>
</tr>
<tr>
<td>It is different and it is making learning fun</td>
<td></td>
</tr>
<tr>
<td>very good</td>
<td></td>
</tr>
<tr>
<td>Nice</td>
<td></td>
</tr>
<tr>
<td>Works well. It's pretty cool</td>
<td></td>
</tr>
<tr>
<td>Its ok</td>
<td></td>
</tr>
<tr>
<td>It is colorful, interesting and fun to work through</td>
<td></td>
</tr>
<tr>
<td>Would make it easier for first timers to understand the concept of programming in cobol</td>
<td></td>
</tr>
<tr>
<td>It is nice</td>
<td></td>
</tr>
<tr>
<td>Extremely eye-catching enabling it to capture your attention</td>
<td></td>
</tr>
<tr>
<td>It looks good</td>
<td></td>
</tr>
<tr>
<td>Looks Great :)</td>
<td></td>
</tr>
<tr>
<td>IT LOOKS FINE</td>
<td></td>
</tr>
<tr>
<td>It's clear, understandable and easy to read from!</td>
<td></td>
</tr>
<tr>
<td>Something new and different.</td>
<td></td>
</tr>
<tr>
<td>Extremely easy to navigate, which therefore makes it more attractive and appealing</td>
<td></td>
</tr>
<tr>
<td>I like CBT. For the first time I'm enjoying pc</td>
<td></td>
</tr>
<tr>
<td>readable</td>
<td></td>
</tr>
<tr>
<td>It’s nice and easy to understand</td>
<td></td>
</tr>
<tr>
<td>Its helpful</td>
<td></td>
</tr>
<tr>
<td>It's just fine</td>
<td></td>
</tr>
<tr>
<td>It is understandable</td>
<td></td>
</tr>
<tr>
<td>It someing new - very creative</td>
<td></td>
</tr>
<tr>
<td>The module is OK so far</td>
<td></td>
</tr>
<tr>
<td>It’s understandable</td>
<td></td>
</tr>
</tbody>
</table>
Some learners indicated some concerns on the interface (Table 4-9) (learner comments were not edited). Several learners complained about the colours that have been used in the module. Furthermore, some learners felt that more attention could be paid to the text. Learners felt that text could be larger and brighter, since it was sometimes difficult to read.

Table 4-9: Learners’ concerns on the general appearance of the CBT module’s interface (Q15)

<table>
<thead>
<tr>
<th>Concern</th>
<th>Learner Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>I do not dislike the colours, but it can be made so that it looks more professional</td>
<td>I do not dislike the colours, but it can be made so that it looks more professional</td>
</tr>
<tr>
<td>the resolution of the computer screens should be increased</td>
<td>the resolution of the computer screens should be increased</td>
</tr>
<tr>
<td>Use better colors</td>
<td>Use better colors</td>
</tr>
<tr>
<td>The text is sometimes too small to read</td>
<td>The text is sometimes too small to read</td>
</tr>
<tr>
<td>Some of the text should have been brighter</td>
<td>Some of the text should have been brighter</td>
</tr>
<tr>
<td>The text in some of the documents is unclear</td>
<td>The text in some of the documents is unclear</td>
</tr>
<tr>
<td>ITS NOT SO EASY TO USE BUT SOMEHOW UNDERSTANDABLE</td>
<td>ITS NOT SO EASY TO USE BUT SOMEHOW UNDERSTANDABLE</td>
</tr>
<tr>
<td>The text is to small and it affects the eyesight, changes should be made to the font and appearance colors</td>
<td>The text is to small and it affects the eyesight, changes should be made to the font and appearance colors</td>
</tr>
<tr>
<td>It is rather dark and not quite clear</td>
<td>It is rather dark and not quite clear</td>
</tr>
<tr>
<td>Cobol work just doesn’t do for me, there are a lot of complications</td>
<td>Cobol work just doesn’t do for me, there are a lot of complications</td>
</tr>
<tr>
<td>at the first time the module was ununderstandable and confusing but now at least it’s better</td>
<td>at the first time the module was ununderstandable and confusing but now at least it’s better</td>
</tr>
</tbody>
</table>

Learners also had to indicate their satisfaction towards the usability of the module in terms of the navigation (Q16), functionality (Q17), and the loading time (Q18) of the module’s lessons (Table 4-10 and Graph 4-17). All DOS1 learners have 24-hour access to the Internet at the CPUT, which allowed download speeds of up to 100 megabytes per second. Each lesson of the CBT module takes approximately 5 seconds to load. With an increase in Internet download speed and the appearance of Web design technologies such as Flash and Authorware, it is becoming easier to add multimedia to Web sites (Vorvoreanu, 2002).
Sixty-two learners (66%) agreed that it was easy to navigate through the module, whereas 11 learners (12%) disagreed. The rest of the learners were uncertain (Q16). A total of 76 learners (81%) felt that all the buttons in the module functioned well, and only one student (1%) disagreed. The other 18% were uncertain (Q17). The last question on the usability and looks of the module (Q18) asked learners whether lessons in the module load quickly. Fifty-four learners (57%) agreed that lessons loaded fast, and 15 learners (16%) indicated the opposite.

Table 4-10: CBT module evaluation tabulation on usability of CBT module (Q16 - Q18)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q16</td>
<td>18</td>
<td>44</td>
<td>21</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Q17</td>
<td>15</td>
<td>61</td>
<td>17</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Q18</td>
<td>6</td>
<td>48</td>
<td>25</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Graph 4-17: Evaluation results for usability of CBT module (Q16 - Q18)
Table 4-11 and Graph 4-18 (Q19) illustrate that 64 learners (68%) agreed that multimedia was appropriately used in the module, while nine learners (10%) disagreed. The rest of the learners (22%) indicated that they were uncertain. Graph 4-18 (Q20) shows that 71 learners (76%) were of the opinion that graphics enhanced the module, and three learners (3%) disagreed. Some of the learners (21%) indicated that they were uncertain.

In addition (Q21), 64 learners (68%) indicated that animation in the module served a specific purpose, whereas six learners (6%) disagreed. The rest of the learners (26%) were not certain (Graph 4-18).

Table 4-11: CBT module evaluation tabulation on usability and looks of CBT module (Q19 - Q21)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19</td>
<td>11</td>
<td>53</td>
<td>21</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Q20</td>
<td>14</td>
<td>57</td>
<td>20</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Q21</td>
<td>16</td>
<td>48</td>
<td>24</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
It can be concluded that the reliability is shown to be high for the interface (I) variable (Questions 9 – 14 and Questions 19 – 21). The reliability coefficient ($\alpha$) of 0.877 indicates that the items (Questions 9 – 14 and Questions 19 – 21) contribute to a reliable scale. The reliability is also shown to be acceptable for the usability (U) variable (Questions 16 – 18). The reliability coefficient ($\alpha$) of 0.752 indicates that the items (Questions 16 – 18) contribute to a reliable scale.

4.2.2.3 CBT module content

The next few questions required learners to comment on the content of the CBT module. Results are shown in Tables 4-12 – 4-19 and Graphs 4-19 – 4-22.
Table 4-12 and Graph 4-19 show that 49 learners (52%) indicated that it took a short time to get used to working with the module (Q22). Furthermore, 69 learners (73%) felt that the amount of work covered versus the time available to complete all the lessons in the module was appropriate (Q23). Most of the learners (69 learners = 73%) also agreed that the length of each lesson was set correctly, and was thus not too long (Q24).

Table 4-12: CBT module evaluation tabulation on content of CBT module (Q22 - Q24)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q22</td>
<td>10</td>
<td>39</td>
<td>34</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Q23</td>
<td>19</td>
<td>50</td>
<td>19</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Q24</td>
<td>16</td>
<td>53</td>
<td>19</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

![Bar chart showing number of learners' responses to questions Q22, Q23, and Q24]
Graph 4-19: Evaluation results on content of CBT module (Q22 - Q24) 

According to Table 4-13 and Graph 4-20, 75 learners (80%) in the experimental group agreed that the content layout was easy to follow, and only three learners (3%) disagreed (Q25). Furthermore, 58 learners (62%) indicated that the difficulty level of the content in the CBT module was appropriate, whereas seven learners (7%) disagreed (Q26).

Table 4-13: CBT module evaluation tabulation on content of CBT module (Q25 - Q26)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q25</td>
<td>19</td>
<td>56</td>
<td>16</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Q26</td>
<td>13</td>
<td>45</td>
<td>29</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
Seventy-one learners (75%) thought that the level of language used in the module was appropriate, while four learners (4%) disagreed with this statement (Q27). In the next question (Q28), 71 learners (75%) indicated that the introduction to each lesson in the CBT module was a good summary of what was to follow, and prepared them sufficiently for the content. Only six learners (6%) felt different and disagreed (Table 4-14 and Graph 4-21).

Table 4-14: CBT module evaluation tabulation on content of CBT module (Q27 - Q28)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q27</td>
<td>18</td>
<td>53</td>
<td>19</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Q28</td>
<td>18</td>
<td>53</td>
<td>17</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 4-15 and Graph 4-22 illustrate that only 38 learners (40%) completed all five lessons of the CBT module (Q29). Forty learners (43%) indicated that they exited from a lesson in the module before completing it (Q30), and 29 learners (31%) referred to their textbooks while working through the module (Q31). Furthermore, 26 learners (28%) indicated that they made notes while using the module (Q32).

Table 4-15: CBT module evaluation tabulation on content of CBT module (Q29 - Q32)

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q29</td>
<td>38</td>
<td>56</td>
</tr>
<tr>
<td>Q30</td>
<td>40</td>
<td>54</td>
</tr>
<tr>
<td>Q31</td>
<td>29</td>
<td>65</td>
</tr>
<tr>
<td>Q32</td>
<td>26</td>
<td>68</td>
</tr>
</tbody>
</table>

Graph 4-22: Evaluation results on content of CBT module (Q29 - Q32)
Table 4-16 lists some of the comments from learners on the content of the CBT module (Q33) (learner comments were not edited). A small portion of the learners did not supply any comments. Learners indicated an overall positive attitude towards the content of the CBT module. The most dominant theme amongst learners was that they found the module to be useful. Learners indicated that the learning material was well compiled and well explained, which ensured that it filled in information detail that was missing from lectures and textbooks.

Table 4-16: Positive comments from learners on the content of the CBT module (Q33)

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOMETHING THE LEARNING MATERIAL WAS NOT DISCUSSED IN CLASS, AND I THINK MANY STUDENTS GOT LOST, THEREFORE THE MODULE SERVED A GREAT PURPOSE</td>
</tr>
<tr>
<td>INTERESTING AND HELPFUL</td>
</tr>
<tr>
<td>It is ok!!</td>
</tr>
<tr>
<td>They are very productive and are straight to the point, I don't think the is anything that was left out except, We don't really know what suprises cobol has!!!</td>
</tr>
<tr>
<td>Perfect</td>
</tr>
<tr>
<td>THE LESSON IS GREAT.</td>
</tr>
<tr>
<td>I think the time allocated for the module is sufficient</td>
</tr>
<tr>
<td>It is done very professional</td>
</tr>
<tr>
<td>Nicely done</td>
</tr>
<tr>
<td>It was useful and I had a better understanding of the work, than previously.</td>
</tr>
<tr>
<td>Very well planned</td>
</tr>
<tr>
<td>They are good, even so we have to have internet bytes to access them</td>
</tr>
<tr>
<td>It's good as is</td>
</tr>
<tr>
<td>Looks smart and friendly to use</td>
</tr>
<tr>
<td>I understand stuff better now</td>
</tr>
<tr>
<td>Helps me to understand Cobol better</td>
</tr>
<tr>
<td>The lesson was great and very helpful</td>
</tr>
<tr>
<td>Extremely worthwhile</td>
</tr>
<tr>
<td>Summarised notes are provided to students</td>
</tr>
</tbody>
</table>
Very well explained  
it works well  
The lesson's are fine  
ITS GREAT  
They are similar to what we are studying therefore making it easier to adapt to these lessons.  
It is quite usefull and understandable better than the way lecturers explain it  
There should be more on-line modules, they are far more interesting, clear and informative  
I STRONGLY SUGGEST IT  
The lessons are well compiled and are appropriate. The lessons are worth going over fo general knowledge and extensive knowledge.  
More lessons are needed  
OK  
It is making me understand what i dont really understand  
the lessos it's quate much understanding and the lecture are trying to give us better way to understand  
The Practical lessons is OK, but Teorie classes is not OK because sometimes I don't know what the lecture is talking about and the lecture must speak more clearly and loader that we can hear what he is saying.

A very small number of learners had different perspectives than their counterparts on the content of lessons in the CBT module (Table 4-17) (learner comments were not edited). The main complaint was that learners could not print learning material. This restricted learners in such way that they had to have access to computers to work through the module content.

Table 4-17: Additional comments from learners on the content of the CBT module (Q33)

| It would be appropriate if all the notes where handed out to us and we do not have to study via a Pc |
| use better colors |
| I prefer traditional teacher-student classes |
| It needs to be given much time |
| Sometimes its challenging |
| The lessons are well compiled and are appropriate. Some of the effects slowed the |
program down and were to some extend unnecessary. Otherwise the lessons are worth going over for general knowledge and extensive knowledge.

Table 4-18 (Q34) lists some of the learner comments on possible improvements they believe can be made to the CBT module. Some of the learners indicated that they would have preferred it if the module could have been printed. This facility will allow learners to read away from the computer screen. Previous studies have shown that learners dislike reading from the screen and in some cases have printed out parts of learning material to avoid having to read from the screen (Wade et al., 1998). Therefore, this feature has been added to the subsequent modules to satisfy learner needs. Furthermore, some learners indicated that the lack of soundcards in computer labs is a limitation, and as a result limited the freedom of development in this research. The initial CBT module was developed in PowerPoint and contained an animated character, which was audible if a soundcard was available. A further limitation was that the animated character could not be incorporated into the Flash module. As found by Apostolos et al. (2005), the effectiveness of CBT was dependent on the quality of the multimedia module while the effectiveness of traditional instruction was dependent on the effectiveness of the lecturer. Few learners left this question blank (learner comments were not edited).

Table 4-18: Recommendations from learners on possible improvements that can be made to the CBT module (Q34)

<table>
<thead>
<tr>
<th>Its alright as it is</th>
<th>IT IS OK</th>
<th>IT WORKS PERFECTLY FOR ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'VE DONE DEVELOPMENT SOFTWARE BEFORE AT ONOTHER TECHNIKON BUT I DIDN'T UNDERSTAND PROGRAMING AT ALL, BUT KNOW I UNDERSTAND WHAT WE HAVE DONE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think there must be more additional lessons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MY UNDERSTANDING OF COBOL HAS IMPROVED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear understanding of Cobol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More on-line modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suggestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More lessons like these with user friendly interfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Different programing languages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Everything seemed good to me</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I CAN HANDLE SOME PROGRAMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the module helped me true COBOL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>There shouldn't be long delays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet access to Residences may be advisable in the future</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More Time to get used to it</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Faster Load Times, More correct information</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faster loading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make the download time shorter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>use better colors , and bigger letters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I think you should setup the program in order to run, with a standard (internet explorer)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allow us to print the flash show</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allow us to print the print the show on the flash player</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>More use of multimedia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use different text</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The sound of the lessons and notes should be on easy reach</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First of all, color usage. The screens need to be a little brighter so that one does not have to strain their eyes in order to follow the lesson. There should be a provision of earphones or no sound usage at all to cater for some who may not have access to a set. As I mentioned before some effects also slow the programme down for instance the swirling of some texts is unnecessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>We need more information so that we can easily understand what's going on</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Table 4-19 (Q35), some of the learner comments are listed on any other aspect of the CBT module they have found to work well. Again, only a small portion of the learners did not supply any comments. Learners indicated an overall positive attitude towards the CBT module. Animation was especially highly regarded by learners. Learners indicated that the navigation features functioned properly and that the ability to work in their own time and at their own pace motivated them (learner comments were not edited).
Table 4-19: Comments on any other aspects of the CBT module that learners have found to work well (Q35)

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE FORMAT OF THE TEST WERE GOOD, AND MARKS WERE AVAILABLE SOON</td>
</tr>
<tr>
<td>AFTERWARDS</td>
</tr>
<tr>
<td>The animation drew alot of interest to the module</td>
</tr>
<tr>
<td>the informatoin is relevant</td>
</tr>
<tr>
<td>Lessons were fair to follow</td>
</tr>
<tr>
<td>ALMOST EVERYTHING</td>
</tr>
<tr>
<td>The CBT module is a very well designed system</td>
</tr>
<tr>
<td>The graphics were very interesting</td>
</tr>
<tr>
<td>It's attractive</td>
</tr>
<tr>
<td>All is good</td>
</tr>
<tr>
<td>Everything</td>
</tr>
<tr>
<td>The lessons</td>
</tr>
<tr>
<td>Navigation as well as operating speed</td>
</tr>
<tr>
<td>EVERY THING IN THE MODULE IS FINE</td>
</tr>
<tr>
<td>Every part of it</td>
</tr>
<tr>
<td>The way the notes are being presented provides a better way of</td>
</tr>
<tr>
<td>understanding since you don't have to rush while reading the note</td>
</tr>
<tr>
<td>but you just have to take your own time to read carefully and be</td>
</tr>
<tr>
<td>able to understand well</td>
</tr>
<tr>
<td>When submitting you get your results quickly back</td>
</tr>
<tr>
<td>Everything was fine</td>
</tr>
<tr>
<td>The lessons are all appropriate. They start from the basics going to</td>
</tr>
<tr>
<td>much harder aspects of the subject. It helps a lot with the</td>
</tr>
<tr>
<td>programmes that we need to build. I give a lot of credit for the</td>
</tr>
<tr>
<td>compilation of the lessons</td>
</tr>
<tr>
<td>So far every thing is working OK and in the future it will better</td>
</tr>
<tr>
<td>learning</td>
</tr>
<tr>
<td>Everything so far is working perfectly</td>
</tr>
<tr>
<td>The module layout is okay but we definately need more information.</td>
</tr>
</tbody>
</table>

The reliability is shown to be high for the content (C) variable (Questions 22 – 32). The reliability coefficient ($\alpha$) of 0.850 indicates that the items (Questions 22 – 32) contributed to a reliable scale, and can therefore be
viewed as an acceptable reliability coefficient.

4.2.2.4 Learner attitude

A number of questions were posed to determine learner attitudes towards the CBT module. Tables 4-20 – 4-23 and Graphs 4-23 – 4-27 show the weighted percentage of satisfaction of learners towards different aspects of the CBT module. The fact that 74% of the learners said that the module contributed to a better understanding of COBOL Report programming, is a good indication that the module has value as a useful learning tool. According to Merrill (1997), “If a product does not teach, it has no value”.

Graph 4-23 (Q36) shows that 70 learners (74%) agreed that the module contributes to a better understanding of the COBOL Report programming topic, and only five learners (5%) disagreed. Learners were asked to indicate whether their experience in using the CBT module was enjoyable (Q38). Most of them (65 learners = 69%) indicated that they found the module enjoyable, but six learners (6%) did not find it as enjoyable (Graph 4-23). Results from Question 39 show that the majority of learners (61 learners = 65%) indicated that the module motivated them to learn, whereas seven learners (7%) felt differently (Graph 4-23).

Table 4-20: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q36, Q38 and Q39)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q36</td>
<td>20</td>
<td>50</td>
<td>19</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Q38</td>
<td>22</td>
<td>43</td>
<td>23</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Q39</td>
<td>20</td>
<td>41</td>
<td>26</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
Graph 4-23: Evaluation results on learners’ attitude towards the CBT module (Q36, Q38 and Q39)

Graph 4-24 (Q37) illustrates that 54% of the learners were of the opinion that they have achieved the objectives for the CBT module as stated in the module’s introduction. The rest (46%) felt that they did not meet the objectives of the content presented in the module.
Table 4-21 and Graph 4-25 (Q40) show that 61 learners (64%) agreed that CBT was easier than traditional instruction. Twelve learners (12%) disagreed and felt that traditional classroom-based instruction was easier. Graph 4-25 (Q41) returned the same results as in Question 40. Sixty-one learners (65%) indicated that CBT was more flexible than traditional instruction, and 11 learners (12%) disagreed. On the question whether learning is better if a combination of CBT and traditional classes are used (Q42), 71 learners (76%) agreed, and five learners (5%) disagreed (Graph 4-25).
Table 4-21: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q40 - Q42)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q40</td>
<td>22</td>
<td>39</td>
<td>21</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Q41</td>
<td>24</td>
<td>37</td>
<td>22</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Q42</td>
<td>28</td>
<td>43</td>
<td>18</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4-22 and Graph 4-26 show that learners thought that the CBT module was useful from a learning point of view. According to results obtained from Question 43, 70 learners (75%) showed that they would like more CBT modules in the future, and 63 learners (67%) indicated that they had a positive attitude towards the module (Q44).
Table 4-22: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q43 - Q44)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q43</td>
<td>25</td>
<td>45</td>
<td>18</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Q44</td>
<td>18</td>
<td>45</td>
<td>25</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Graph 4-26: Evaluation results on learners’ attitude towards the CBT module (Q43 - Q44)

Table 4-23 and Graph 4-27 illustrate that 71 learners (75%) stated that the module identified strengths and weaknesses in their understanding (Q45). Furthermore, 76 learners (81%) indicated that CBT was beneficial to the DOS1 subject (Q46).
Table 4-23: CBT module evaluation tabulation on learners’ attitude towards the CBT module (Q45 - Q46)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q45</td>
<td>22</td>
<td>49</td>
<td>18</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Q46</td>
<td>29</td>
<td>47</td>
<td>15</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Graph 4-27: Evaluation results on learners’ attitude towards the CBT module (Q45 - Q46)

The reliability is shown to be high for the attitude (A) variable (Questions 36 – 46). The reliability coefficient ($\alpha$) of 0.884 indicates that the items (Questions 36 – 46) contribute to a reliable scale, and can therefore be viewed as an acceptable reliability coefficient.
4.2.2.5 Pre- and post-test component

The next seven questions in the online questionnaire asked learners to indicate whether they agreed or disagreed with some statements on the pre- and post-tests. In Table 4-24 and Graph 4-28 (Q47), results show that 73 learners (78%) were satisfied with the multiple-choice format of the pre- and post-tests, and six learners (6%) were not as satisfied. Seventy-two learners (77%) indicated that they were satisfied with the standard of the pre- and post-tests, whereas six learners (6%) disagreed (Q48). On the question whether learners felt that the pre- and post-test questions were relevant, 76 learners (81%) agreed, and none of the learners (0%) disagreed (Q49).

Table 4-24: CBT module evaluation tabulation on results from the pre- and post-tests (Q47 - Q49)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q47</td>
<td>28</td>
<td>45</td>
<td>15</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Q48</td>
<td>29</td>
<td>43</td>
<td>16</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Q49</td>
<td>28</td>
<td>48</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Furthermore, Table 4-25 and Graph 4-29 (Q50), show that 76 learners (81%) agreed that questions in the pre- and post-test were clearly worded, and five learners (5%) disagreed. Learners were also asked whether the layout of questions was clear. Eighty-one learners (86%) agreed, whereas two learners (2%) disagreed (Graph 4-29).

Table 4-25: CBT module evaluation tabulation on results from the pre- and post-tests (Q50 - Q51)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q50</td>
<td>27</td>
<td>49</td>
<td>13</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Q51</td>
<td>28</td>
<td>53</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
The second last question on the pre- and post-tests (Q52) indicated that 79 learners (84%) agreed that the level of language used in the test was understandable, and only one learner (1%) disagreed (Table 4-26 and Graph 4-30). For the last question on the pre- and post-tests (Q53), Graph 4-30 illustrates that 76 learners (81%) agreed that the feedback provided for test questions was helpful, and only one learner (1%) disagreed.

The reliability is shown to be high for the pre- and post-test (PP) variable (Questions 47– 53). The reliability coefficient ($\alpha$) of 0.940 indicates that the items (Questions 47 – 53) contributed to a reliable scale, and can therefore be viewed as an acceptable reliability coefficient.
Table 4-26: CBT module evaluation tabulation on results from the pre- and post-tests (Q52 - Q53)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q52</td>
<td>31</td>
<td>48</td>
<td>14</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Q53</td>
<td>36</td>
<td>40</td>
<td>17</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Graph 4-30: Evaluation results on the pre- and post-tests (Q52 - Q53)

4.2.2.6 Most valuable and least valuable aspects of CBT module

In the last two open-ended questions of the questionnaire learners had to comment on what they perceived were the least valuable (Table 4-27) and the most valuable (Table 4-28) aspects of the CBT module (learner comments were not edited).
Table 4-27: Comments from learners on what they thought was least valuable about the CBT module (Q54)

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>the basics of programming</td>
</tr>
<tr>
<td>Nothing to me everything is important</td>
</tr>
<tr>
<td>Nothing so far. Course everything in the bigging is set to be enjoyable!!!!</td>
</tr>
<tr>
<td>I really can't say.</td>
</tr>
<tr>
<td>So many notes</td>
</tr>
<tr>
<td>Nothing</td>
</tr>
<tr>
<td>NOTHING - It is valuable</td>
</tr>
<tr>
<td>GIVING ME CHANCE DOING WHAT I LIKE SOLVING PROBLEMS</td>
</tr>
<tr>
<td>Nothing i would say</td>
</tr>
<tr>
<td>TO BE HONEST I DON'T HAVE ONE</td>
</tr>
<tr>
<td>Nothing. Every lesson of this module proved to be vital</td>
</tr>
<tr>
<td>NOTHING AT ALL</td>
</tr>
<tr>
<td>nothing, everything is usefull</td>
</tr>
<tr>
<td>Practical periods, we don’t have lecturers</td>
</tr>
<tr>
<td>The labs do not open during weekends for practicing</td>
</tr>
<tr>
<td>I don't have anything negative to say</td>
</tr>
<tr>
<td>Nothing really</td>
</tr>
<tr>
<td>Nothing! It is a nice experience about cobol and stuff.Knowing how actualy how many things operate,especially</td>
</tr>
<tr>
<td>The discussion board, perhaps because i find it unnecessary due to the fact it is time consuming</td>
</tr>
<tr>
<td>Nothing. Everthing help me</td>
</tr>
<tr>
<td>Nothing at all. The questions provided are enough to help me understand what is going on in cobol report programming and i am a slow worker that needs all the time i can get cobol is old</td>
</tr>
<tr>
<td>Nothing I can think of now...</td>
</tr>
<tr>
<td>Not having a pc at home can be to one's disadvantage</td>
</tr>
<tr>
<td>Nothing least valuable, because the every part of the module is linked to each other</td>
</tr>
<tr>
<td>It is not clearly understandable for some people who aren't used to learning using the computer because the notes can't be saved and later printed</td>
</tr>
<tr>
<td>Nothing I can put my finger to at the moment. On a scale of one to ten I would give a 7.</td>
</tr>
<tr>
<td>I dont see any thing that is least valuable</td>
</tr>
<tr>
<td>i DONT SEE ANYTHING THAT IS THE LEAST IN THIS MODULE</td>
</tr>
<tr>
<td>It is difficult it needs more time</td>
</tr>
</tbody>
</table>
THIS PRESENTATION STYLE MADE IT NICE TO LEARN, BUT MAYBE IT WAS A BIT TO EXTRAVIGANT
A SIMPLER TYPE OF FORMAT WOULD HAVE BEEN EASIER

Table 4-28: Comments from learners on what they thought was most valuable about the CBT module (Q55)

<table>
<thead>
<tr>
<th>learning cobol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everything. To know a lot is an advantage.</td>
</tr>
<tr>
<td>Everything</td>
</tr>
<tr>
<td>It enhances your way of thinking to a level you never knew you had before, your mind is more open and you want to know more</td>
</tr>
<tr>
<td>Sufficient notes and relevant</td>
</tr>
<tr>
<td>IT STRONG WORK WITH MULTI-MEDIA</td>
</tr>
<tr>
<td>It is interesting. It will help us in the future</td>
</tr>
<tr>
<td>The fact that it has sound and I work better with my music/sound.</td>
</tr>
<tr>
<td>PEOPLE SHOWING THAT THEY LIKE THERE WORK TO ASSISTS US TO HAVE BETTER UNDERSTANDING</td>
</tr>
<tr>
<td>Practical work and theory go together so it's balanced and very important for 1st year students</td>
</tr>
<tr>
<td>ALMOST EVERYTHING</td>
</tr>
<tr>
<td>learning in general</td>
</tr>
<tr>
<td>easy to learn I think</td>
</tr>
<tr>
<td>Everything</td>
</tr>
<tr>
<td>The use of the computers</td>
</tr>
<tr>
<td>The learning experience :)</td>
</tr>
<tr>
<td>the use of computers (to write test and other many things)</td>
</tr>
<tr>
<td>The layout, it made it more interesting and understandable</td>
</tr>
<tr>
<td>It helped us understand how the cobol programs work</td>
</tr>
<tr>
<td>Helps us to try and understand how the Cobol programs work</td>
</tr>
<tr>
<td>The flash study guides, The graphic approach to learning makes it interesting</td>
</tr>
<tr>
<td>ITS VERY INFORMATIVE</td>
</tr>
<tr>
<td>the multimedia presentations and extra notes</td>
</tr>
<tr>
<td>Easy to understand and study from!!</td>
</tr>
<tr>
<td>It explains everything that lecturers might have left out in class</td>
</tr>
<tr>
<td>How technology operates. Because it is fun knowing how electronic devices were build and why they operate the way they do</td>
</tr>
</tbody>
</table>
Comments on the least valuable aspects of the module proved to be very positive. Learners universally agreed that they found “nothing” to be least valuable. Most of the learners enjoyed working with the CBT module and were of the opinion that it improved their DOS1 knowledge. In general, learners were of the opinion that the module increased their motivation
and that more modules should be incorporated into the subject. Learners indicated that the animations were extremely valuable, and that the graphic approach made the learning process more interesting. Learners were satisfied with the module content and found it to be informative and easy to understand.

Even though the t-tests did not reveal any significant difference in knowledge gain between the control group and experimental group, the data has shown that more learners in the experimental group favoured the CBT format. Although not directly supported by the pre- and post-test scores, the evaluation showed that the multimedia CBT format retained the learning interest of learners better than that of the traditional format. Furthermore, learners tended to show a preference for hard-copy learning material. This can be attributed to the fact that with hard-copy material, learners can highlight information, it is easier to read, and it is portable. The majority of the learners acknowledged the various potential strengths of CBT and indicated a preference for the module.

4.3 INTERPRETATION OF RESULTS

As described earlier, the summative evaluation procedure involved a control/experimental group pre-test/post-test approach to evaluate the effectiveness of using a CBT module. The primary performance measure was the gain score which was computed from the pre-test/post-test scores for learners in each group. Gain scores can control individual differences in pre-test scores by measuring the post-test score relative to each learner’s pre-test score. Gain score analysis does not control differences in pre-test scores between the groups. This is accounted for by performing a t-test on pre-test scores between both groups (Balasubramanian, 2002:42-43). To ascertain whether the CBT module was effective, t-tests were performed.
It was hypothesised that CBT would lead to similar post-test scores than traditional instruction. The gain score should therefore be positive. A positive gain score indicates a better post-test score than a pre-test score, whereas a negative score indicates a post-test score that is less than the pre-test score.

Results support the null hypothesis (Paragraph 1.4), and therefore prove that CBT instruction is as effective as traditional instruction when applied to the DOS1 subject.

Qualitative data was obtained by means of a questionnaire to provide data concerning the learning process (learner satisfaction towards CBT instruction). It was of importance that data on learners’ interactions and comments be collected concerning the learning process while learners use the CBT module (Jones et al., 1996). Harvey (1998:10) is of the opinion that qualitative data is generally more useful in establishing improvements necessary for users of a system, or to benefit learners on a programme.

Results on learner perceptions of the use of CBT in the DOS1 subject were encouraging. The module was highly rated by the learners, and attributed to an increase in their understanding of the topics. Despite the limited interactivity of the module, it had proved to be popular with the learners, especially those from disadvantaged backgrounds struggling with DOS1. In general the learners responded with enthusiasm, and found the CBT module non-threatening and easy to use and follow. This research maps to the research findings of Holt et al. (2001:540) that state that below average learners find CBT particularly useful. Holt et al. (2001) found that conventional classroom-based instruction is less likely to assist learners with a lower knowledge base if compared to CBT. They found that CBT learners were motivated to spend more time on learning and improved their knowledge accordingly. In a study by Ramsey (1996:24), results have proved that the original learning phase of the experiment showed no
significant differences between the two instructional methods. Results in our research are consistent with the findings in similar literature reviews.

The only concern regarding the qualitative data that was gathered is the relatively high “uncertain” response rate that was reflected in response to some of the questions. This author assumes that learners interpreted the “uncertain” option as a neutral response, where they could either agree or disagree with a particular statement.

4.4 SUMMARY

The most important conclusion from this research is that the overall results of the experimental group (CBT instruction) were comparable to the control group (traditional instruction). Learners who made use of the CBT module performed equivalent to, or at least as good as learners who attended traditional classroom lectures. Furthermore, learners indicated an overall positive attitude toward the CBT module. Results obtained during the course of this project therefore support the null hypothesis of this research.
CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 RESEARCH SUMMARY

This chapter concludes the research with a summary drawn from the analysis of data in Chapter 4. Based on the results obtained from this research, various guidelines for the development of CBT modules are presented. The results obtained were compared with similar research that had been conducted elsewhere. Some comments were then made relating to possible implications of the research findings. Recommendations were supplied with regard to the viability of CBT and the potential of this type of instruction. Finally, the chapter is concluded with a discussion on the research results and some possible research options for future research in the DOS1 subject.

The main goal of this research was to develop an interactive CBT module and to quantitatively and qualitatively evaluate its effectiveness. The formative evaluation process was used to evaluate the attitude of learners toward the CBT module, whereas summative evaluation centred on measuring learner performance towards using the CBT module. The effectiveness of the module was determined by comparing the pre- and post-test results.

Differences between the pre- and post-tests for both groups were analyzed by means of a t-test. Furthermore, gain scores between the pre- and post-tests conducted for a control group (classroom-based instruction) and an experimental group (CBT instruction) were used as measures of effectiveness. Both groups showed a positive gain, however there was no significant difference between the pre- and post-test scores within each
group. Gain scores between the control group and experimental group also did not indicate a significant difference, yet this does not impact upon the value of this research. The null hypothesis (Paragraph 1.4) was thus supported due to the fact that both groups obtained a higher post-test score than on the pre-test.

Even though results showed a higher gain for the experimental group, all comparisons of CBT instruction to classroom-based instruction are not warranted if the results are generalized. An earlier study by Leung (2003) proved that e-learning did not show a significant difference in learner performance, whereas studies by Blanchard (1990) as well as Compeau and Higgins (1995) could not conclusively illustrate which instruction proved to be more effective, except under each study’s unique conditions. Although this research could not conclusively demonstrate which instruction method is most effective, it can be said that CBT instruction matched or was as least as effective as classroom-based instruction.

Interactive, multimedia instruction can result in cognitive gains and learner satisfaction compared to traditional teaching methods. This suggests that CBT can be an effective supplement to traditional instruction. Multimedia can be utilised as a motivational tool and a valuable supplement in training (Poobrasert, 2002). In addition, CBT allows for a more flexible and versatile method of instruction (Engum et al., 2003:73). CBT can also promote active learning, because it encourages learners to take an active role in the learning process. This enables learners to have better control over their education (Apostolos et al., 2005). Even though the CBT module used in this research did not show a significant difference in learner gain scores, it is believed that the DOS1 subject should incorporate CBT in the curriculum. Though learners are still dependent on paper-based notes, textbooks and lecturers for their learning, CBT will ensure improved learner satisfaction that cannot be achieved with traditional classroom-based instruction alone.
Qualitative data was obtained by means of a questionnaire to determine learner satisfaction towards CBT instruction. Learner evaluations helped to determine the effectiveness of the CBT module. Evaluations also deal with areas that may need adjustment, and they communicate to learners that their input is valuable (Cooper, 2000).

The module was well-received. In general, learners found the CBT module useful and would like more such modules in the future. There was no significant objection to the standard of the questions in the pre- and post-tests. The level of language used was also acceptable to the learners. The majority of the learners claimed that the feedback had improved their understanding of the CBT module content. They also indicated that the feedback was clear and understandable. In this research, the CBT module supplied the learners with a general sense of satisfaction, as it was perceived as useful, easy to use, flexible and stimulating. It is clear from the positive feedback from learners, that the CBT module could be a valuable addition to classroom instruction, practical classes, textbooks, and other resources used in the DOS1 subject.

All these results suggest that multimedia can have a positive effect on learning if appropriately integrated into the DOS1 subject. Future learners should benefit from similar CBT modules, especially if more topics are added. The CBT module has the potential to develop into a valuable source for DOS1 learners acquiring basic DOS1 skills. It cannot be concluded that other learners will feel as motivated as the experimental group in this research. It is believed that their positive responses resulted from the novelty of using a CBT module, and their feelings of success as their performance improved.
5.2 CONCLUSION

An important goal of CBT is that it should be better or at least equivalent to classroom-based instruction. The findings of this research maps to previous studies and are thus in line with previous research results. Key findings from this research are that there was no significant difference in the performance between the control group and experimental group. The pre-test scores, post-test scores and gain scores for both groups were similar. Tucker (2001) states that a lack of significant difference in test scores, may indicate that one delivery method is not superior to the other. As a result, this research concludes that while CBT may not be superior to or better than traditional instruction, it is not worse than traditional education. It can be applied as an acceptable alternative because it proved to be as good as traditional instruction. If a CBT module is constructed well, it should produce results which are similar to (or better than) an equivalent traditional classroom-based lecture (Beckstrand, 2002).


If CBT material is well-designed and applied appropriately, learners and lecturers can benefit from increased satisfaction with the learning process. Even though CBT had a similar impact in this research on learner performance compared to classroom-based instruction, the observation can be made that CBT can be used as a motivational tool. The CBT module can therefore provide the learner with an important additional
resource and facilitate an alternative mode of instruction (Lewis, 2003). This author believes that supplementing lectures with CBT modules in the DOS1 subject proved to improve learner performance. Given that the CBT module is far from optimal, and having just started data collection on learner performance and attitude, this author believes that it will be possible to prove a significant learner knowledge gain in the near future. This can be achieved by using interactive, multimedia CBT modules in conjunction with traditional lectures.

Research by Roesch et al. (2003) returned that despite the vast number of advantages of CBT, it is important to recognize that CBT cannot replace traditional face-to-face instruction. Therefore, both methods of instruction (CBT and traditional) should complement each other in the future in the DOS1 subject at the CPUT.

The conclusion of this research is that an interactive CBT module used in a DOS1 subject, indicated an insignificant difference in learner gain scores between a CBT and IBT group. Regardless of the insignificant difference that was found between and within the two groups, the CBT learners performed equivalent to their IBT counterparts. CBT learners also indicated an overall positive attitude towards the module. This author can thus state that CBT is as effective as IBT when applied in the DOS1 subject.

5.3 CONTRIBUTIONS OF THE RESEARCH

Results show that the CBT module lead to improved learning motivation and contributed to a positive attitude towards teaching the COBOL programming language. In addition the module also contributed to a better understanding of COBOL Report programming. This is a good indication that the module has value as a useful learning tool. Furthermore, learners had to interact with the module which in turn
focused on learner behaviours and contributed to the effectiveness of the CBT module.

5.4 FUTURE RESEARCH

This research determined that CBT is an effective means of training first year DOS1 learners. However, its acceptance as a formal training tool is not favourable. It is suggested that traditional and computer-based instruction should in future be incorporated into the DOS1 subject. CBT modules should also be continuously updated and improved. Online learning material requires revision and updates each time it is delivered.

Future research should also consider testing additional topics. A limitation of this research was its small scale and its relatively short duration. Since the research was limited to six weeks, it could not be determined whether the CBT module had an effect on learners’ long term retention or whether it had an effect on their future learning processes. It is possible that the time period that the learners made use of the CBT module was perhaps insufficient to affect learner understanding of the programming language. Smith and Woody (2000:220) observed that a multimedia group performed poorly early in the term but slightly exceeded a traditional group towards the end of the term. Research can be conducted over a longer time period (e.g. semester or year) in order to average out any possible errors due to variations in content delivery.

Furthermore, several additions and improvement will be implemented in the CBT module as a result of the evaluation reported in Section 4.2.2. From the learners’ point of view one of the main concerns of the module was its colour and text. To improve the general appearance of the module the format and colour of screen and text will be changed. Text will also be re-sized to be in a more readable form to learners. Animations will still be present in future modules, as it was enjoyed by learners in its current form.
Furthermore, no changes will be made to the existing animations. The researcher recommends further research in the tertiary DOS1 environment in order to empower learners.

Advice from Basson (2002) will be followed in that lecturers should test the learners on a continuous basis on lessons to be completed or just completed. Thus, if there are areas not fully understood by the learners, it will be noticed and the lecturers have a chance of spending more time on that particular topic. This will ensure that the subject matter and speed thereof is adapted on a continuous basis in order to achieve maximum understanding of the subject as well as better results in learner marks.
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APPENDIX A
DATA FROM SUMMATIVE EVALUATION
APPENDIX A: DATA FROM SUMMATIVE EVALUATION

Table A-1: Pre-test and post-test data from summative evaluation for control (traditional instruction) group

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APPENDIX B
PRE-TEST
APPENDIX C
POST-TEST
APPENDIX D
QUESTIONNAIRE
APPENDIX E
LECTURE NOTES
Attitude
A learned predisposition to respond positively or negatively to certain objects, situations, concepts, or persons.

Computer-based training (CBT)
Computer-based training is a method of delivering training material through a personal computer without the need for a live facilitator.

Human-computer interaction (HCI)
HCI is concerned with the design, evaluation and implementation of interactive computing systems.

Instructor-based training (IBT)
This type of instruction consists of training in a physical location where learners are physically present and receive instruction from a live facilitator.

Interactivity
Interactivity is when a software program allows the user to participate by providing a response, which involves an information exchange between the user and the computer.

Internet
The Internet was initially created for government agencies to share information, but has now grown into a worldwide network of government, industrial, and private computer systems that can interact and share information.
**Intranet**
Intranets are private networks of interconnected computers, within in organization. Unlike the Inter, and intranet is not publicly accessible and information can only be shared with others on the private network.

**Multimedia**
Multimedia is any interactive application that integrates text, colour, graphical images, animation, sound, and video.

**Programme**
A programme refers to a course of academic studies.

**s.a. (sine anno)**
Without date.

**s.l. (sine loco)**
Without place of publication.

**Usability**
Usability measures the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and attitude of its users toward it.

**Web-based training (WBT)**
WBT can enable learners to access their programme material from anywhere in the world while being engaged in self-directed learning activities.