PROCEEDINGS

7th ANNUAL CONFERENCE ON WORLD WIDE WEB APPLICATIONS

29-31 August 2005

Cape Town
South Africa

Publisher:
University of Johannesburg
PO Box 524
Auckland Park
2006

URL: http:www.zaw3.co.za

ISBN 0-620-35079-2

TO WHOM IT MAY CONCERN

Herewith to testify that the papers accepted for the 7th Annual Conference on World Wide Web Applications, 29-31 August 2005, Cape Town have been peer-reviewed by independent and external peer-reviewers.

Prof P.A. van Brakel
Conference Chair
7th Annual Conference on WWW Applications
c/o Faculty of Business Informatics
Cape Peninsula University of Technology
Cape Town

+27 21 469-1015 (landline)
+27 82 966-0789 (mobile)

A pilot study on the development and evaluation of an interactive computer-based training (CBT) module

S Lourens
Business Informatics/Cape Peninsula University of Technology
Cape Town
South Africa
lourenss@cput.ac.za

M Weideman
E-Business/Cape Peninsula University of Technology
Cape Town
South Africa
weidemanm@cput.ac.za

Abstract

The main objective of this study is to prove whether or not an interactive multimedia computer-based training (CBT) module will help learners understand learning material better. The secondary objective is to measure if learners will show a positive attitude towards CBT in the COBOL programming language in a Development Software 1 programme.

A relatively large number of learners fail DOS1 each year and it is increasingly apparent that it would be prudent to supplement the learning experiences of these learners. Research has shown that learners using interactive multimedia material can have a learning advantage over learners receiving classroom-based education. However, little research has been done in the teaching of programming languages.

The methods employed in this study 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 COBOL. Furthermore, the effects of CBT on learners' attitude were evaluated.

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 asked to complete an online questionnaire for evaluation of the module and their attitude towards it.

Preliminary results seem to indicate that the even though the experimental group (who made use of the CBT module) has obtained a higher mean gain score than the control group (who received traditional classroom-based instruction), it proved to be insignificant. Gain scores between the two groups did not indicate any significant improvement however, it appears as if CBT education has a positive effect on learners' attitudes.

The conclusion of this study is that CBT did not show a significant improvement in learner performance, but lead to heightened motivation in teaching the COBOL programming language.

Keywords: computer-based training, multimedia, usability, attitude, performance.

1. Introduction

During the last few years computers have played and increasing role in education. 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 programme material or online tests.

During the last few years it has become evident that first year Development Software 1 (DOS1) learners at the Cape Peninsula University of Technology (previously known as Cape Technikon), find it difficult to master learning material from textbooks and lectures alone. As the capabilities of computers increase, it becomes more attractive to use them as a potential aid to teach academic subjects such as DOS1. It is internationally recognized that computers can assist to address this need by providing interactive learning experiences to learners (Frith, 1997b). The 21st century's learning model uses the computer as an instrument for teaching and learning. Today computers are incorporated into the learning process and are seen as an integral delivery component in Information Technology education.

Research by Blank *et al.* (2002) has proved that multimedia does contribute to objective learning. An experimental evaluation conducted 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. The counterparts received traditional classroom-based instruction.

Multimedia has been incorporated into several facets of instruction over the last few years and offers great possibilities for communicating technical information in a clear and concise fashion. The interactive use of multimedia components such as text, graphics, sound, animation, digital slide shows, videos as well as quizzes can facilitate the learning process. Multimedia may also aid in motivation and attention improvement processes. 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.

Adams (1992) has shown that learners that use interactive web delivered multimedia had a 55% learning gain over learners receiving traditional classroom teaching. Blanchard (1990) has also found that learners who used a hypermedia learning system showed a significant increase in mean test scores between the pre-test and post-test.

The author's premise is that an interactive multimedia computer-based training (CBT) module can help learners understand learning material better. CBT can result in increased learner academic performance and satisfaction. CBT can also provide the flexibility from traditional teaching to flexible learner-centred teaching. The educational value of using such a CBT module is perceived as an option to complement and not replace traditional classroom-based education.

The purpose of this study is to compare the traditional learning methods to the use of multimedia in a CBT module. The author hypothesizes that the CBT module could potentially improve learner academic performance and satisfaction.

2. Literature review

Primary research figures that compare multimedia-based training benefits to those of instructor-led training come mainly from industry groups such as Federal Express, IBM and General Motors (Issa *et al.*, 1999:285). Today many companies see CBT as an effective and efficient training method. Results by Forman[1] cited by Issa *et al.* (1999:285), show that the learning gains of employees who received multimedia instruction were 50% - 60% higher compared to their counterparts who received traditional instruction.

Authoring tools (e.g. Java, HTML editors, Visual Basic, Authorware, Director, Toolbook etc.), make it possible to develop teaching materials 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. There is a belief that CBT material can increase student learning and satisfaction. However, it is accepted that CBT material can be used to provide quality education, but cannot necessarily replace lectures, tutorials or practicals (Frith, 1997c). It is important to realize that in this study the CBT module is implemented to function as additional training material and not to replace classroom lectures. Alessi and Trollip also state that:

> "the computer has an important role in instruction alongside the teacher, the book and other instructional media" (Allessi & Trollip, 1991:3).

Issa *et al.* define an instructional method as:

> "an informational plan to develop reasoning skills and transmit a body of knowledge to a target audience. Instructional methods also include motivating and accurately measuring the group's comprehension of the material" (Issa *et al*., 1999:282).

Issa *et al*. also state that:

> "the irreplaceable link in education is an effective understanding of how people learn and how best to simulate an adequate understanding of the desired material" (Issa *et al*., 1999:282).

Gaytan and Slate (2003:193) cite Pryor[2], who pointed out that several researchers (Atkinson, 1984; Bangert-Drowns, Kulik and Kulik, 1985; Fletcher, 1990; Fletcher, Hawley and Piele, 1990) found technology-based instruction to be more effective than conventional instruction. Dykman (1994) noted that the Hudson Institute found computer-aided instruction (CAI) to have produced an increase in learning and timesavings by 30% and 40% respectively.

During the last few years the use of multimedia has become more widely used in different facets of instruction. However, a relatively small amount of research documents the effectiveness of multimedia in teaching and learning. 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.

---

[1] Forman, D.C. 1995. The use of multimedia technology for training in business and industry. *Multimedia Monitor*, July:23-27.

[2] Pryor, B.W. 1992. *Streams of knowledge, streams of action: The river of research and development at technology based learning and research, Arizona State University*.

Furthermore, Callon[3] as cited in Gaytan and Slate, used multimedia in college math classes during a pilot project and found that:

> "the use of computer technology in calculus classes led to students demonstrating a much better grasp of fundamental concepts and they are more adept problem solvers than those taught under traditional formats without any loss of computational or manipulative skills. Formal class evaluations … documented improved student attitudes towards learning and increased faith in their abilities to work things out for themselves. Instructors … also noted that students are better at working independently, and yet seem to have developed more of a working relationship with their instructors and with their classmates" (Gaytan & Slate, 2003:194-195).

Multimedia offers possibilities for communicating technical information clearly and concisely. Multimedia includes the use of a combination of text, graphics, animation, video, music, voice and sound effects to communicate. Unlike television, radio and video, interactive multimedia allows the viewer/listener to play an active role in the experience. Interactive multimedia allows the user to control information flow. According to Hofsetter multimedia is:

> "the use of computers to present and combine text, graphics, audio, and video with links and tools that let the user navigate, interact, create, and communicate" (Hofsetter, 1993:22).

Savage and Vogel argued that multimedia technology brings significant benefits to lecturers such as the:

- Refreshing 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 organizing and maintaining the multimedia databases, and
- improvement of lecturer/learner interaction etc. (Savage and Vogel, 1996).

Gaytan and Slate cite Townsend and Townsend[4] who also listed several multimedia benefits including the following:

- It provides a sense ownership to the user,
- it reaches all ages,
- it encourages and validates self-expression, and
- it creates an interactive learning environment (Gaytan & Slate, 2003:193).

Learners using multimedia instruction in Education Psychology also produced a better knowledge base than learners who received classroom-based instruction (Delclos & Hartman, 1993).

---

[3] Callon, G.D. 1992. Computers in calculus (and throughout the mathematics curriculum).

[4] Townsend, F.C. & Townsend, C.M. 1992. Meeting learning needs through multimedia: A look at the way modern technology can help classroom teachers meet the varied instructional needs of students.

Deacon *et al.* (2000) conducted a study at the University of Cape Town and investigated how computer-based information technology could be utilized in supporting fourth year B.Comm. learners. They created an integrated project-based learning environment for a multidisciplinary commerce course by customizing the Microsoft Office suite. As with some prior studies, this study produced positive results and indicated that computer-based tutorials will make significant contributions to the fourth year B.Comm. programme.

Another study by Engum *et al.* (2003:71) compared the effectiveness of computer-based education with traditional learning methods. Results showed a significant improvement in cognitive gains and learner satisfaction. According to Kozma:

> "learning is an active, constructive, cognitive, and social process by which the learner strategically manages available cognitive, physical, and social resources to create new knowledge by interacting with information in the environment and integrating it with information already in memory" (Kozma, 1994).

After using CBT, post-test accuracy for food services workers at a hospital improved significantly from the pre-test. The CBT also had a positive impact on a wide range of workers (Eckerman *et al.*, 2004:317).

Research conducted by Jung *et al*. (1998) found 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.

In a series of surveys 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 is improved by Web-based learning activities, and learners perceive Web-based learning material to be a more effective learning aid than traditional resources.

3. Methodology

According to Delclos and Hartman:

> "Meaningful investigation of the impact of interactive multimedia applications on teaching and learning should include both attitudinal and behavioral components. Attitudinal assessment focuses on the views of students and instructors towards multimedia tools and technology and encompasses such factors as ease of use, accessibility to workstations, and facilitation of other learning activities. The behavioral component of this assessment focuses on student performance and can be measured with a variety of qualitative and quantitative methods" (Delclos & Hartman, 1993:92).

Goldstein defines evaluation as:

> "the systematic collection of descriptive and judgmental information necessary to make effective training decisions related to the selection, adoption, value, and modification of various instructional activities" (Goldstein, 1993:181).

In this study evaluation forms an important part in the evaluation of the CBT module. Firstly, to determine the effectiveness of CBT, and secondly, to make changes to the module if necessary.

Evaluation is a broad term and can be used to investigate:

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

Several research activities have been addressed in this study:

- A prototype Macromedia Flash CBT module was developed,
- the module was evaluated using formative evaluation techniques, and
- summative evaluation was used to measure the effectiveness of the module.

This was compared against the effectiveness of lecture-based instruction.

During formative evaluation data was collected to revise and refine the module to make it more effective and efficient. Formative evaluation helps to collect information during the development of training programs which can be used to improve the effectiveness of the training (Dick & Carey, 1996). Data for this purpose was gathered by means of an online questionnaire.

According to Dick and Carey (1996), summative evaluation is carried out to verify the effectiveness of instructional material with target learners. In order to perform 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 their attitude towards CBT. The summative evaluation method chosen is the field trial method.

In this study evaluation is seen as an integral part of the research in both the evaluation of the prototype module to make changes if necessary, and the determination of the effectiveness of the training. Compared to a laboratory experiment, the main advantage of the field trail method is that the learners could use the CBT module from any location at any given time.

The field trail consisted of four parts. First, all learners had to complete an online test (pre-test) prior to either receiving classroom-based instruction or CBT instruction. Second, the learners had to work through either the CBT module during a one and a half week period (experimental group), or they had to attend classroom-based instruction (control group). Third, after the one and a half week period, all learners had to complete another online test (post-test). Fourth, only learners who made use of the CBT module had to complete an online evaluation questionnaire. The experimental design used in this study is illustrated in Table 1.

Table 1: Experimental design

Group 1	R	T1	X1	T2	
Group 2	R	T1	X2	T2	Q1

Group1	=	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

3.1 Participants

A total of 206 learners participated in this study (n = 206). Class groups were randomly assigned to either the control group (n = 112) or experimental group (n= 94). The random selection of class groups, instead of individual learners, ensured consistency between the two groups (control group and experimental group) with regard to the profile of the participants.

3.2 Prototype CBT module

A well-designed, interactive, multimedia CBT module was perceived as one way to complement traditional classroom-based instruction. 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 module for this purpose. Another purpose was to determine whether CBT could improve learning in the DOS1 programming environment. The module was developed to complement existing programme material and to make it more clear, visual and self-paced.

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 immediately identified and that the user 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 that he/she does not yet fully understand, or to spend less time on sections they feel confident with. This enables a learner to use his/her time more efficiently. With the CBT module, the learner can select a topic of choice, move between screens, and exit the module at any given time. Learners can skip work they feel confident with or they can return to a specific screen to repeat information.

The module educates in the following manner:

- Module introduction to introduce the user to the module,
- training objectives,
- lesson overview, and lastly
- feedback on performance.

Prototyping (Ambler, 2001; Ambler, 1998) is an iterative analysis technique in which users are actively involved in the mocking up of screens. The prototype module was thus used to show learners the possible designs for the user interface. The graphical user interface (GUI) is extremely important. It has to be both simple and attractive; otherwise, learners will not use the tool (Abraham et. al, 2001). 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. Constantine (1995) has pointed out 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.

Good user interface design is important for several reasons. An intuitive user interface results in ease of use. A good user interface results in ease of training people to use it and less user support. The better the user interface the more likely users will use it and indirectly increase their satisfaction (Ambler, 2000). Usability relates to the user's satisfaction towards the module, ease of use of the module and the effective use by the users.

Davis (1989:319) demonstrated that perceived ease of use and usefulness are fundamental determinants of user acceptance. Lohr (2000) also specifies numerous design guidelines in his work. These include the principles for aesthetic appeal, comprehensibility, compatibility, consistency, efficiency and responsiveness to name just a few. Other important guidelines include Nielsen's (1993) heuristics such as simple and natural dialog, consistency, shortcuts, feedback, help and minimization of memory load etc.

The Rapid Application Development (RAD) model was used in the development of the CBT module. This model is considered to reduce the time required to deliver high quality software. The RAD development lifecycle is designed to give faster development and higher quality results than the traditional lifecycle (Balasubramanian, 2002:13-14). To use RAD development for web courses, involves the use of packages such as Java, HTML editors, Visual Basic, Authorware, Director, Toolbook etc. In our case Macromedia Flash was used as a development tool. Macromedia Flash is a powerful and easy to use tool. Animation can add interactivity as well as three-dimensional elements to procedures or concepts.

The CBT module is available on the university's local network as well as on the Internet via the WebCT platform. This environment provides students with an interactive, multimedia CBT module, and the developers with a framework for authoring, managing, monitoring and evaluating CBT material.

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

- Easy delivery,
- easy updating of information,
- controllable access,
- availability of additional resources via links (Balasubramanian, 2002:9),
- progressing at own pace (allows learner to control the learning process e.g. order of presentation, number of repetitions),
- repetition (learners can repeat learning material as much as they want), and
- self-directed (learners can choose topics for study from example a menu).

Biggs (1999:93-95) states that learner activity and interaction constructs knowledge. The development of the CBT module strived to make learners active learners. Interactivity is an important aspect of CBT material that helps learners learn by doing (Blank *et al.*, 2002). Hannafin and Peck (1988:8) state that interaction is the most often credited attribute that contributes to the effectiveness of computer-aided instruction (CAI) sessions. Interactivity means that the learner needs to participate. This in turn means that the media requires learner input to improve the learning process. This learning process takes the learner out of the passive role (listen and respond) to individually interact with the module. Participation also requires learner attention to progress through the module. Learner attention or comprehension is not necessarily guaranteed by passive listening (Issa *et al.*, 1999:281).

As with previous research, Jeffries *et al.* (2003:73) also found that the use of interactive multimedia results in knowledge gains. This finding suggests that learners can be taught as effectively with multimedia as with traditional lectures. Results from this study also revealed that learners had fun with the learning process.

Gaines *et al.* (1996) also concluded that technology helped move the act of learning from hearing (and forgetting) and seeing (and remembering) to doing (and understanding), which represented a more active way of learning.

A study by Issa *et al.* (1999) proved that multimedia-based instruction enhances a learner's interaction with programme material. They also found that the time taken to achieve a satisfactory level of comprehension, improved.

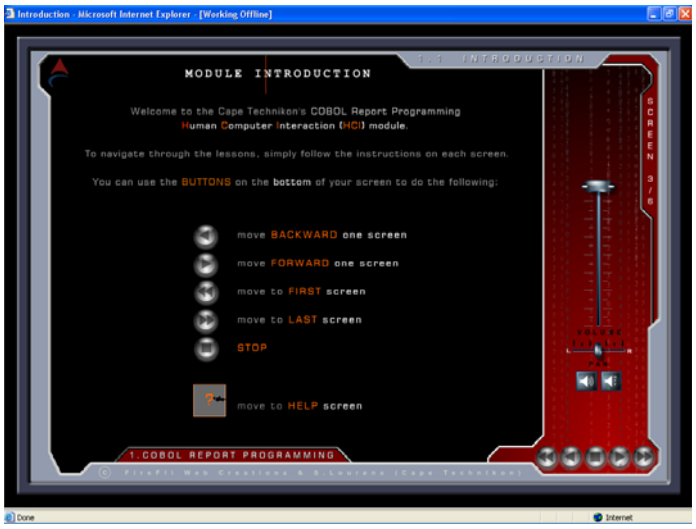
Hashiba *et al.* also note that:

> "students can use the Internet to browse interesting lectures at their own convenience … to receive instruction at locations away from an instructor. It allows for independent pace adapted directly to the student's needs" (Hashiba *et al.,* 2000:240).

Each screen of the CBT module is divided into two parts. The left side of the screen is mostly used to explain a topic, whereas the right side of the screen is mostly used to supply information of importance (except for the introduction screens). Each introduction 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 progress through the module. The red banner at the bottom of each screen informs the learner of the module's title.

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. The Quit screen will then be displayed. Navigation instructions on how to use the module are specified in the module's introduction (Figure 1).

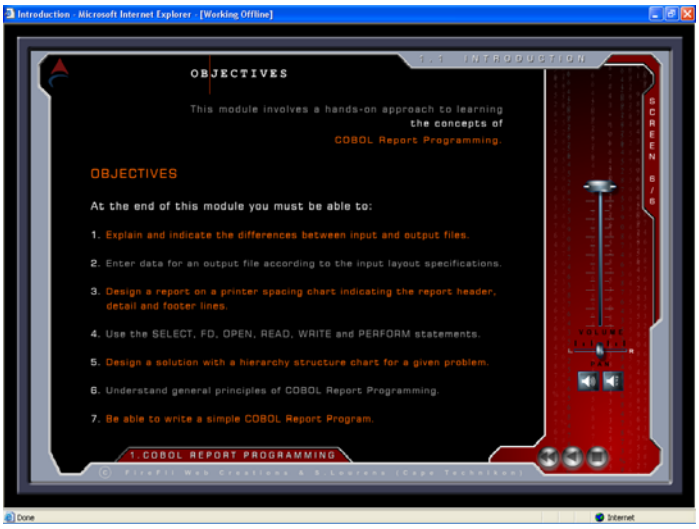
Figure 1: The module introduction screen



The next few screens introduce the learner to the content (Figure 2) and objectives of the module (Figure 3).

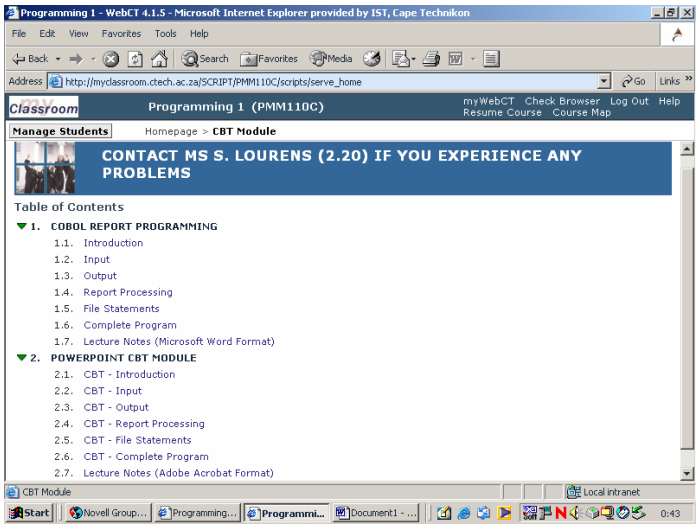
Figure 2: The module content screen

Figure 3: The module objectives screen



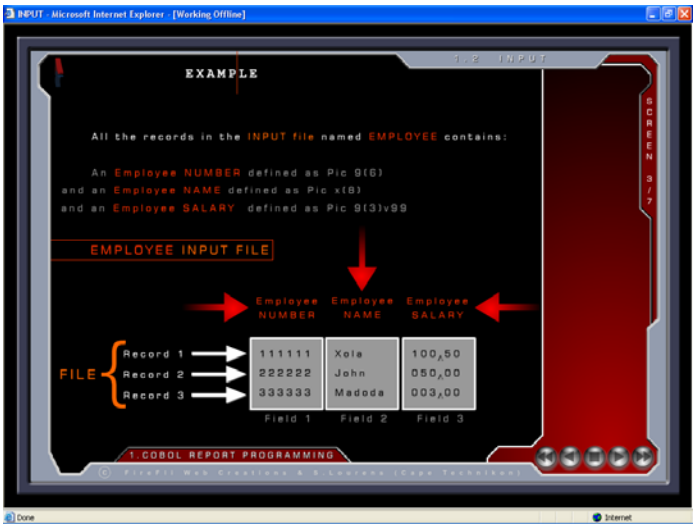
After the introduction the learner can choose from the WebCT environment which lesson to complete (Figure 4).

Figure 4: WebCT screen with lesson topics



Each lesson starts with a loading screen that is followed by a title page. Each lesson guides the learner through different topics in an entirely self-paced manner (Figure 5). Visual content, that includes animated and still graphics, is supported with clarifying text. The module serves as supplemental learning material in the DOS1 programme and is not developed to replace classroom-based lectures.

Figure 5: Example of a content screen



The initial development of the module required a considerable amount of time and effort. However, the template of the module can be re-used for future modules. This will ensure the quick development on new topics.

It is important 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, the times it is made available etc. (Frith, 1997a).

3.3 Pre- and post-tests

An experimental pre-test/post-test approach was used to evaluate whether learners performed better when using the CBT module or attending traditional classroom-based instruction.

Learners were divided into two groups. Groups, rather than individuals, were randomized into a control group (who received traditional classroom instruction) and experimental group (who received CBT instruction). As in a study conducted by Jeffries *et al.* (2003:73), groups were randomized for reasons related to programme scheduling, and lecturer and lab availability. Because groups have been randomly assigned to either a control group or experimental group, most internal threats to validity were controlled. The pre-test verified whether both groups have more or less the same knowledge.

Summative evaluation was used in an online pre-test/post-test approach to determine the effectiveness of the module with the use of the CBT instruction as an experimental group and the traditional classroom-based instruction as a control group.

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. Each test consists of 25 multiple-choice questions, with questions presented in a random fashion to each learner.

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 analyzed rapidly to provide the lecturer with immediate results about learners' performance. The pre-test was given to learners to evaluate the knowledge prior to additional CBT or classroom-based instruction.

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 was conducted in the same manner as the pre-test, and completed using the same group of learners as with the pre-test. After completion of the post-test, the experimental group completed an online questionnaire. Both tests were used in the summative evaluation procedure to collect gain scores.

Learner responses are stored in WebCT, which performs item analysis on each question separately and gives an average score for the whole group. This function enables the lecturer to obtain instant feedback on learner performance.

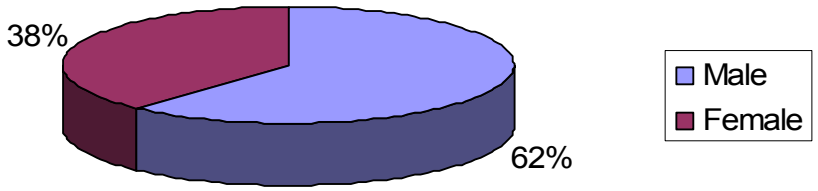
If the field trail was not designed with care, it could have resulted in difficulty to interpret the data. The reason for this is that evident improvement of performing a task could result from factors such as sensitization to the area due to pre-testing or intuition rather than training alone (Goldstein, 1993). Similar to research conducted by Balasubramanian (2002:39), both groups completed the same pre-test and post-test, therefore sensitization was equal in both groups. This in turn equally affected the data from the post-test of both groups.

3.4 Questionnaire

After completion of the CBT module, a formative approach was followed. 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. A questionnaire is the most convenient way to collect information. Many learners' views can be collected at once and significantly comparative measurements can be made (Frith, 1997a).

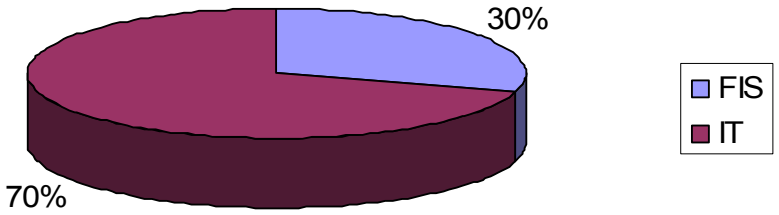
Only the experimental group (n = 94), who made use of the CBT module, completed the questionnaire. The gender demographics of the learners consisted of 58 (62%) males and 36 (38%) females (Figure 6).

Figure 6: Proportion of males and females who completed the questionnaire (experimental group)



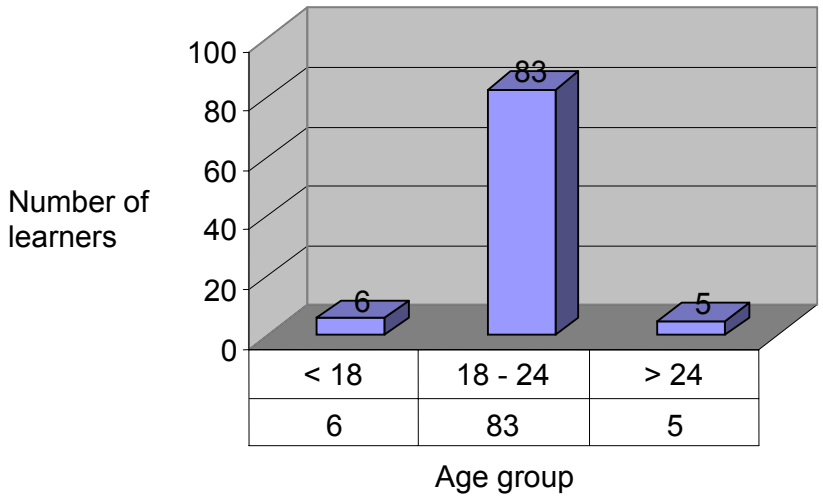
Learners who completed the questionnaire were enrolled in either the Information Technology (IT) programme (70%) or the Financial Information Systems (FIS) programme (30%) - (Figure 7).

Figure 7: Proportion of learners enrolled for the Financial Information Systems (FIS) and Information Technology (IT) programme



The majority of learners' age ranged between 18 and 24 years. Only six learners were younger than 18 years. Five learners indicated that they are older than 24 years (Figure 8).

Figure 8: Learner age



The questionnaire contained 55 questions. These were formulated to evaluate different aspects of usability, learner attitude, satisfaction and the impact CBT had on their learning process. After completing demographic questions (e.g. age, gender programme enrolled for, 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 type questions were used to mainly collect user satisfaction rating scores. Several open-ended questions were also included in the questionnaire to allow learners to provide personal feedback on the CBT module. The questionnaire took approximately 15 minutes to answer.

4. Results and analysis

The mean pre-test score for the control group (classroom-based instruction group) was 12.94 out of a possible 25 (SD=3.31). The range of scores was large (28% to 92%). The mean post-test score (out of 25) for the control group was 16.54 (SD=3.78) with a wider range of scores (16% to 96%).

The mean pre-test score (out of 25) for the experimental group (CBT instruction group) was 12.88 (SD=3.51). The range of scores was large (24% to 92%). The mean post-test score (out of 25) for the experimental group was 16.51 (SD=3.34) with a narrower range of scores (28% to 92%). 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) – see Table 2.

Table 2: Pre-test & post-test data from summative evaluation

	Number of learners	Pre-test score Mean (SD)	Post-test score Mean (SD)	Gain score
Control group	112	12.94(3.31)	16.54(3.78)	3.60(4.23)
Experimental group	94	12.88(3.51)	16.51(3.34)	3.63(3.91)

Pre-test and post-test scores for both groups are illustrated and summarized in Figures 9 and 10. Gain scores for both groups are illustrated in Figure 11.

Figure 9: Pre-test vs. post-test scores (control group)

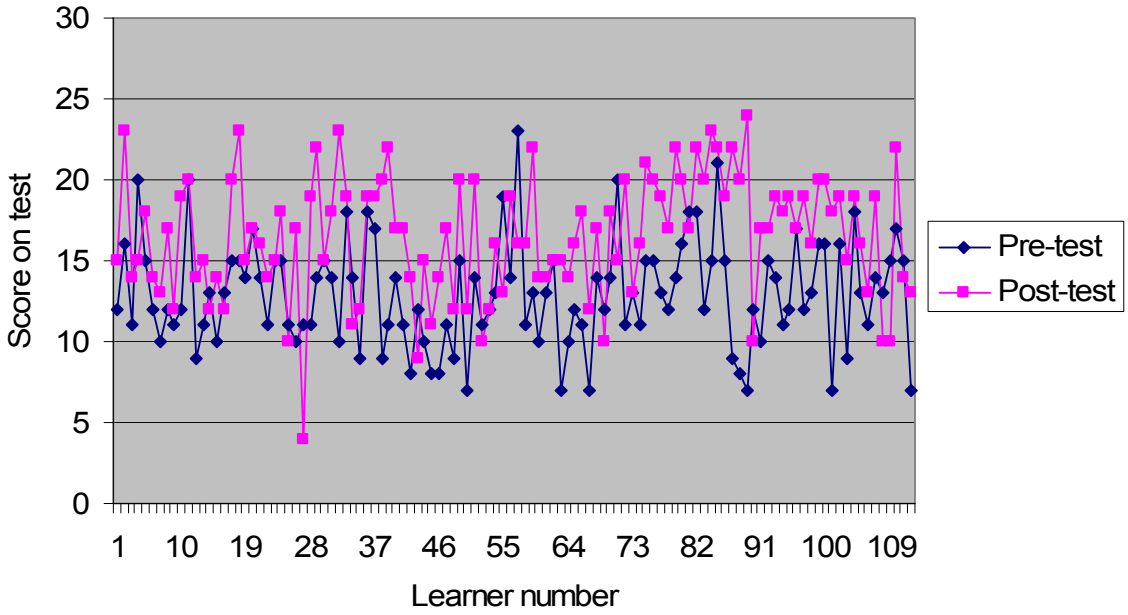


Figure 10: Pre-test vs. post-test (experimental group)

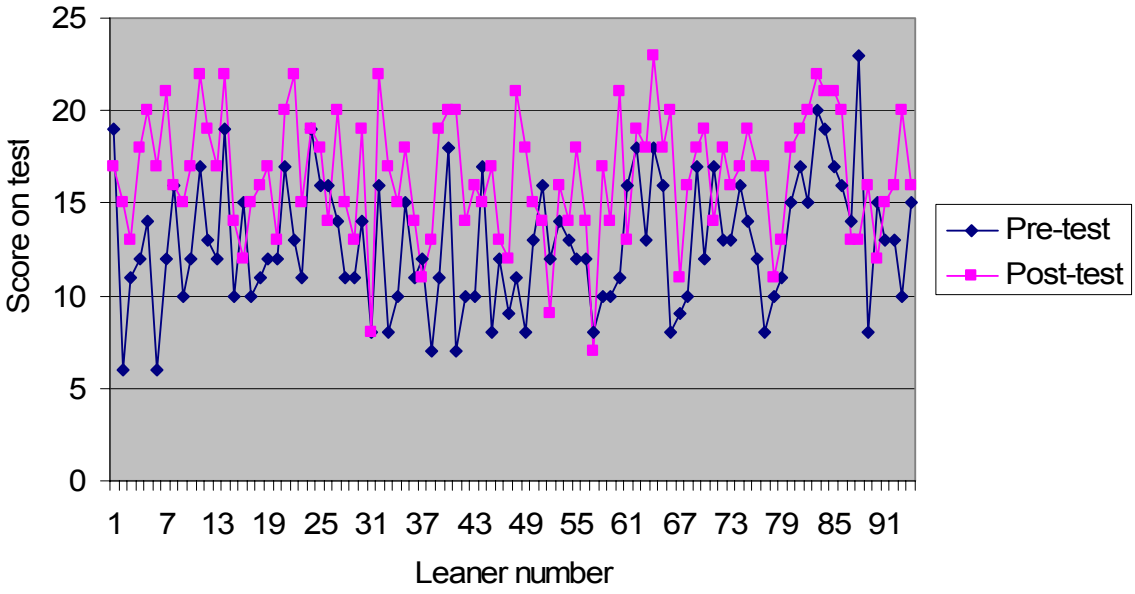
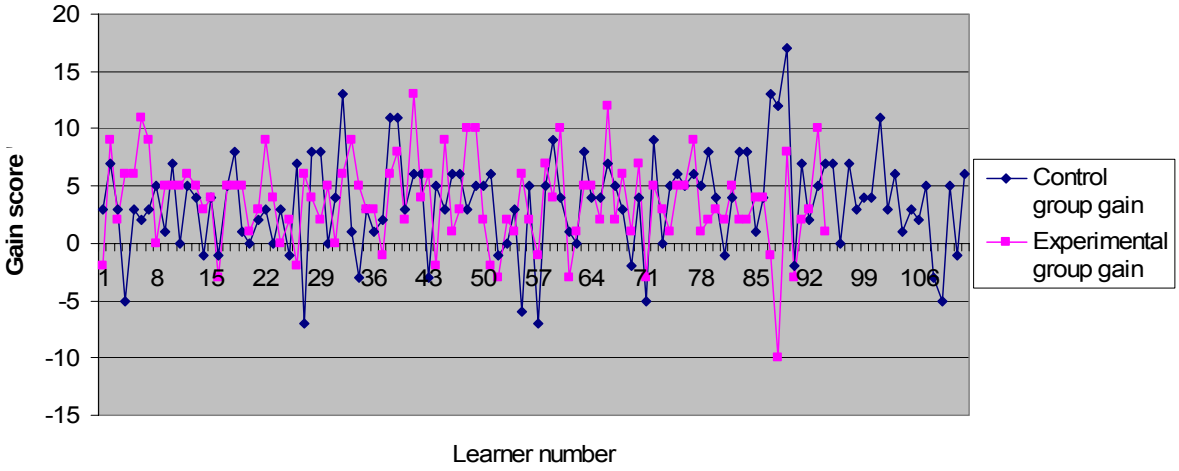


Figure 11: Gain score comparison between control group and experimental group



To determine whether the CBT module was effective between the experimental group and control group, t-tests were performed. 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 are no significant differences between the two groups' pre-test scores.

A paired t-test was performed within each group (FIS and IT) 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 indicate no significant difference at $\alpha = 0.05$ for the control group, that confirms that there is not a 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 ($p > 0.05$) show no significant difference at $\alpha = 0.05$ for the experimental group, that confirms that there is 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 null hypothesis was not supported by the p result of 0.959 that indicates that there is no significant difference between the gains for both groups.

The 0.12% gain ascertained that CBT instruction was not more effective than 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.

Results obtained from the questionnaire indicate that the learners showed a general sense of satisfaction, because it was perceived as useful, easy to use, flexible and stimulating.

5. Discussion

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 that is computed form the pre-test/post-test scores for learners in each group (control and experimental group). To ascertain whether the CBT module was effective, t-tests were performed. 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.

It was hypothesized that CBT would lead to higher post-test scores. The gain score should therefore be positive. 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).

Qualitative data was obtained by means of a questionnaire to determine learner satisfaction toward CBT instruction. Results indicate that the learners showed a general sense of satisfaction when using the CBT module. Feedback from the questionnaire proves that an interactive, multimedia CBT module could result in greater learner satisfaction.

6. Conclusion

The main goal of this study was to develop an interactive CBT module and to quantitatively evaluate its effectiveness. The formative evaluation process was used to evaluate the 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-test and post-test results. 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.

Gain scores between the pre-test and post-test 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-test and post-test scores within each group. Gain scores between the control group and experimental group also did not indicate a significant difference.

Even though results show a higher gain for the experimental group, all comparisons of CBT instruction to classroom-based instruction are not warranted if these 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) and Compeau and Higgens (1995) could not conclusively illustrate which instruction proved to be more effective, except under each study's unique conditions. Although this study could not conclusively illustrate which instruction method is most effective, it can be said that CBT instruction matched 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 used as an effective supplement to traditional instruction. In addition, CBT allows for a more flexible and versatile method of instruction (Engum *et al.*, 2003:73). Even though the CBT module used in this study did not show a significant difference in learners' gain scores, we still believe that CBT should be incorporated into the DOS1 programme. This 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. In this study the CBT module supplied the learners with a general sense of satisfaction, because it was perceived as useful, easy to use, flexible and stimulating. Results proved that an interactive, multimedia CBT module could result in greater learner satisfaction. All these results suggest that multimedia can have a positive effect on student learning if it is appropriately integrated into a programme.

Our results differ from previous studies that show that variables collectively influence novice learning of computer systems (Nielsen *et al.*, 1994). The reason for this is that previous work treated independent variables as a whole and tried to measure their effect on the measure variable. In this study however, we seek to address the effect of only one variable – the effect of a CBT module on learner performance.

An important goal of CBT is that is should be better or at least equivalent to classroom-based instruction. They key findings from our study is 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.

Not withstanding the fact that findings from our study differ from research results in the literature review, it confirms the results of research done by Leung (2003:135), and Wegner *et al.* (1999). Both Leung and Wegner *et al.* found an insignificant difference between the test scores of an e-learning group and classroom-based group. Furthermore, results from a study by McKethan and Everhart (2001) also showed that there were no significant differences in scores between a multimedia group and lecture group. These results are consistent with research conducted by Deer et al. (1995) and Skinsley and Brodie (1990).

Even though CBT had a similar impact on learner performance compared to classroom-based instruction in our study, we would like to add that CBT can be used as a motivational tool. It can also serve as a valuable supplement to learner instruction.

7. Bibliography

Abraham, D., Crawford, L., Lesta, L., Merceron, A. & Yacef, K. 2001. The Logic Tutor: A Multimedia Presentation. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning, 3*. [Online]. Available WWW: http://www.imej.wfu.edu/articles/2001/2/03/printver.asp (Accessed 4 May 2004).

Adams, G. 1992. Why Interactive? *Multimedia and Videodisc Monitor*. 10(3):20-24.

Alessi, S.M. & Trollip, S.R. 1991. *Computer-based instruction: methods and development*. 2nd Edition. New Jersey: Prentice Hall.

Ambler, S.W. 1998. *Building object applications that work: your step-by-step handbook for developing robust systems with object technology*. New York: Cambridge University Press.

Ambler, S.W., 2000. User interface design: tips and techniques. [Online]. Available WWW: http://www.ambysoft.com/userInterfaceDesing.pdf (Accessed 5 December 2004).

Ambler, S.W. 2001. The Object Primer 2nd edition: The application developer's guide to object orientation. New York: Cambridge University Press. [Online]. Available WWW: http://www.ambysoft.com/theObjectPrimer.html (Accessed 23 January 2005).

Balasubramanian, V. 2002. Design and evaluation of a web-based training tool for the User Action Framework explorer. Unpublished thesis, Virginia Polytechnic Institute and State University, Blacksburg.

Biggs, J. 1999. *Teaching for quality learning*. Buckingham: Society for Research into Higher Education and Open University Press.

Blanchard, D. 1990. A Computer Aided Instruction program: teaching the disk operating system to community college learners. Unpublished thesis, Center for advancement of education, Nova University.

Blank, G.D., Pottenger, W.M., Kessler, G.D., Roy, S., Gevry, D.R., Heigl, J.J., Sahasrabudhe, S.A. & Wang, Q. 2002. Design and Evaluation of Multimedia to Teach Java and Object-Oriented Software Engineering. In: *Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition*, June 2002:17-18.

Compeau, D. & Higgens, C. 1995. Application of Social Cognitive Theory to Training for Computer Skills. *Information Systems Research*, 6(2):118-143.

Constantine, L.L., 1995. *Constantine on Peopleware*. Englewood Cliffs, NJ: Yourdon Press.

Davis, F. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Management Information Systems Quarterly*, 13:319-338.

Deacon, A., Paxton, M. & Carr, T. 2000. Creating a project-based learning environment for commerce courses by customizing an Office suite. [Online]. Available WWW: http://www.meg.uct.ac.za/papers/citte.htm (Accessed 8 December 2003).

Deer, R., Wright, K. & Solomon, A. 1995. A comparison of student performance following instruction by computer-assisted instruction versus traditional lecture method for an undergraduate athletic training program. *KAHPERD Journal*, 31:18-20.

Delclos, V.R. & Hartman, A. 1993. The impact of an interactive multimedia system on the quality of learning in educational psychology: An exploratory study. *Journal of Research on Computing in Education*, 26(1): 83–93.

Dick, W. & Cary, L. 1996. *The systematic design of instruction*. 4th Edition. New York: Addison Wesley Longman, Inc.

Dykman, A. 1994. Ready for the technoworld*? Vocational Education Journal* 69(6), 28-24.

Eckerman, D.A., Abrahamson, K.I., Ammerman, T., Fercho, H., Rohlman, D.S. & Anger, W.K. 2004. Computer-based training for food services workers at a hospital. *Journal of Safety Research*, 35:317-327.

Engum, S.A., Jeffries, P. & Fisher, L. 2003. Intravenous catheter training system: Computer-based education versus traditional learning methods. *The American Journal of Surgery*, 186:67-74.

Frith, V. 1997a. Evaluation of courseware for higher education. [Online]. Available WWW: http://www.civeng.uct.ac.za/caleng/eval.htm (Accessed 26 March 2004).

Frith, V. 1997b. How can CAL make teaching and learning more effective? [Online]. Available WWW: http://www.civeng.uct.ac.za/caleng/caladv.htm (Accessed 26 March 2004).

Frith, V. 1997c. The evaluation of computer-based teaching aids. [Online]. Available WWW: http://www.civeng.uct.ac.za/caleng/caleng.htm (Accessed 26 March 2004).

Gains, C., Johnson, W. & King, T. 1996. Achieving technological equity and equal access to the learning tools of the 21st century. *T.H.E Journal*, 23(11):74-78.

Gaytan, J.A. & Slate, J.R. 2003. Multimedia and the College of Business: A Literature Review. *Journal of Research on Technology in Education*, 35(2):186-205.

Goldstein, I.L. 1993. *Training in organizations – needs assessment, development, and evaluation*. 3rd Edition. California: Brooks/Cole Publishing Company.

Hannafin, M.J. & Peck, K. 1988. *The design, development and evaluation of instructional software*. New York: Macmillan Publishing Company.

Hashiba, M., Inagawa, K., Matsuto, T., Motonaga, A., Yamakawa, T. & Akazawa, K. 2000. Application of the RealAudio package to computerized medical lectures. *Medical Informatics & The Internet in Medicine*, 25(4):239-245.

Hix, D. & Hartson, H.R. 1993. *Developing user interfaces: Ensuring usability through product and process*. New York: John Wily & Sons, Inc.

Hiltz, S.R. 1994. *The virtual classroom. Learning without limits via computer network.* Norwoord: Ablex Publishing.

Hofsetter, F.T. 1993. Design and construction of a multimedia technology catt. *Techtrends*, 38(2):22-24.

Issa, R.R.A., Cox, R.F. & Killingsworth, C.F. 1999. Impact of Multimedia-based Instruction on Learning and Retention. *Journal of Computing in Civil Engineering*, 13(4):281-290.

Jeffries, P.R., Wool, S., & Linde, B. 2003. Technology-based vs. Traditional Instruction: A Comparison of Two Methods for Teaching the Skill of Performing a 12-Lead ECG. *Nursing Education Perspective*, 24(2):70-74.

Jung, D.J., Keel, R.O. & Irons, L.R. 1998. Interactivity in distance education: The Missouri IVPTF experiment. In: *Proceedings of the International Conference on the Social Impact of Information Technologies*, October 1998. St. Louis: Missouri.

Kozma, R. 1994. A reply: media and methods. *Educational Technology in Research and Development*, 42(3):11-14.

Leung, H.K.N. 2003. Evaluating the Effectiveness of e-Learning. *Computer Science Education*, 13(2):123-136.

Lohr, L.L. 2000. Designing the instructional interface. *Computers in human behaviour*. 16(1):161-182.

McKethan, R. & Everhart, B. 2001. The Effects of Multimedia Instruction and Lecture-Based Instruction On Learning and Teaching Cues of Manipulative Skills on Preservice Education Teachers. *Physical Educator*, 58(1):2-13.

Nielsen, J. 1993. *Usability engineering*. Boston: Academic Press.

Nielsen, J. & Levy, J. 1994. Measuring usability: preference vs. performance. *Communications of the ACM*, 37(4):66-75.

Savage, T. & Vogel, K. 1996. Multimedia: A revolution in higher education? *College Teaching*, 44(4):127-131.

Skinsley, M. & Brodie, D. 1990. A study of the effectiveness of computer assisted learning in physical education. *Research Supplement*, 7:14-16.

Technology and student success. 3rd Edition. 2002. McGraw-Hill Ryerson:171.

Wegner, S.B., Hollaway, K.C. & Garton, E.M. 1999. The effect of internet based instruction on student learning. *Journal of Asynchronous Learning Networks*, 3(3).

8. Acknowledgements

The author wishes to thank the Cape Peninsula University of Technology for the provision of a research assistant and also Prof. Melius Weideman for his supervision and guidance.