THE EVALUATION OF COMPUTER BASED TRAINING AS A METHOD OF TEACHING MAP READING IN A MILITARY CONTEXT

Anje Conradie

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Supervisors:
Dr. M. Cilliers-Hartslief
Prof. C.C. Theron

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

ABSTRACT

Map reading forms an integral part of every soldier's training. Although all troops are exposed to map reading during basic training, they thereafter do not frequently work with maps on a daily basis, but are still required to apply this knowledge during field exercises or combat situations. Various forms of training are available. Computer Based Training (CBT) is a technique that may contribute to the improved acquisition and retention of knowledge when the subject matter requires of students to visualise concepts, as CBT engages multiple senses. CBT incorporates principles from the Component Display Theory and Constructivism, which suggest that CBT might result in superior map reading competencies when used as an alternative to conventional, classroom based, map reading instruction.

The objective of this study was firstly to determine whether CBT, compared to conventional classroom instruction, enhances the acquisition of knowledge when teaching users how to read a two-dimensional (2D) map. In addition, the study had as its objective to determine whether CBT leads to improved retention of 2D map reading knowledge over a one month period when compared to conventional instruction. Finally the study aimed to determine the factors that influence learning when using CBT as the training medium.

A basic randomised, between subjects research design, was used to test the hypotheses that CBT would result in the improved acquisition and retention of 2D map reading competencies. The control group consisted of 30 students and the experimental CBT group of 29 students. All subjects were personnel from the School of Armour of the South African National Defence Force. With regards to map training, the majority of the students had exposure to Geography up to grade 12 or further training.

A new training programme was designed. The programme was developed in two equivalent formats, one appropriate for conventional classroom instruction (control group), and a CBT format for the experimental group. Each student received two manuals. One was a self-study manual that had to be completed before commencing with the course, and the other was received on the first day of the course. Both the trainers also received a manual that contained all the correct answers to the map reading problems forming part of the programme.

The CBT programme was designed on paper with the help of a template for the storyboard. A lesson was designed for each day of the course, but students could review any lesson previously studied. Before the students started with lesson 1, they had to complete a test on the computer to determine the extent to which they have acquired the information in the self-study manual. After passing the test the students could select lesson 1. A mind-map was designed for each lesson to help students orientate themselves.

For both groups the information studied was placed in the context of "Operation Night Owl", an interactive practical mission. The CBT group had the computer as a guide, providing textured maps and possible answers.

Three tests were used to evaluate the students and to gather data regarding their performance. The students were not informed about these tests as the researcher wanted to measure natural acquisition and retention, and not the amount of time that they had studied.

Analysis of variance (ANOVA) indicated that the two groups did not differ statistically significantly (p>,05) in their initial degree of map reading knowledge. The average test percentage increased from the pre-test to the first post-test (knowledge acquisition), indicating that the class group increased by 15,2 % and the CBT group by 19 %. Hypothesis 1 states that CBT in comparison to traditional instruction enhances the acquisition of map reading knowledge when

teaching users how to read a 2D map. The difference between the class and CBT means for post-test 1 (knowledge acquisition) was, however, statistically insignificant (p>,05).

A comparison of the means of the post-test 2 (retention) results of the class and CBT groups clearly indicates that the performance levels retained one month after training, also do not differ statistically significantly (p>,05). The study therefore also fails to corroborate the hypothesis that CBT would result in the greater retention of map reading knowledge when compared to conventional classroom instruction.

Based on the results found when CBT results were compared with the traditional classroom technique, it may be advisable to combine classroom teaching with CBT. During the completion of the mission segment of the course, students tended to form natural groups to complete the questions. As working together may result in better understanding of new information (peers learn from each other), it is therefore recommended that the CBT map-reading course be combined with more discussion groups.

In conclusion, the results do not suggest that CBT is a superior training technique for the teaching of map reading competencies. Numerous literature sources however do indicate that CBT can contribute significantly to the learning experience, making it still plausible that CBT could indeed, upon further refinement of the programme, contribute to teaching of map reading competencies.

OPSOMMING

Kaartlees vorm 'n integrale deel van elke soldaat se opleiding. Alhoewel elke soldaat blootgestel word aan kaartlees tydens basiese opleiding, word daar nie op 'n daaglikse basis daarmee gewerk nie. Dit bly egter nodig om kaartlees tydens veld-oefeninge en aanvalsituasies toe te pas.

Verskillende vorme van opleiding is beskikbaar t.o.v. die aanleer van kaartleestegnieke. Rekenaargebaseerde Onderrig (RGO) is 'n tegniek wat veelvoudige gewaarwordinge insluit, en dus 'n bydrae tot beter leer en retensie van kennis kan lewer, wanneer dit van die student verwag word om konsepte te visualiseer. RGO sluit eienskappe van Komponent-tentoonstellingsteorie en Konstruktiwiteitsteorie in wat tot verbeterde kaartlees bevoegdheid mag lei indien dit as 'n alternatief tot die konvensionele klaskamer-gebaseerde kaartlees gebruik word.

Die doel van die studie was eerstens om vas te stel of RGO, in vergelyking met die konvensionele klaskamermetode, 'n groter bydra lewer in die leer en retensie van kennis wanneer studente geleer word om 'n 2-dimensionele (2D)-kaart te lees. Tweedens stel die studie dit ten doel om vas te stel of RGO, in vergelyking met die konvensionele metode, tot verbeterde retensie van 2D-kaartlees kennis oor 'n een-maand tydperk lei. Laastens beoog hierdie studie om vas te stel watter faktore leer beïnvloed wanneer RGO as 'n opleidingsmedium gebruik word.

'n Basiese, ewekansige, tussen-groep navorsingsontwerp is gebruik om die hipotese dat RGO sal lei tot die verbeterde leer en retensie van 2D-kaartlees-bevoegdhede, te toets. Die kontrolegroep het bestaan uit 30 studente en die eksperimentele RGO-groep uit 29 studente. Die steekproef was troepe van die Pantserskool van die Suid Afrikaanse Weermag. Die meerderheid van die steekproef het blootstelling aan Aardrykskunde tot graad 12 of verder gehad.

'n Nuwe opleidingsprogram is ontwerp. Die handleidings is ontwerp in 'n formaat geskik vir konvensionele klaskamer instruksie (kontrole groep) so wel as 'n formaat geskik vir RGO (eksperimentele groep). Elke student het twee handleidings ontvang. Die een was 'n self-studiehandleiding wat voor die aanvang van die kursus voltooi moes word, en die ander een is op die eerste dag van die kursus ontvang. Albei die instrukteurs het ook 'n handleiding ontvang wat die korrekte antwoorde rakende die kaartleesprobleme bespreek in die program bevat het.

Die RGO program is op papier ontwerp met die hulp van 'n skermplaat. 'n Les is uitgewerk vir elke dag van die kursus, maar studente kon enige van die vorige behandelde lesse hersien. Voordat die studente met les 1 kon begin moes elkeen eers 'n toets op die rekenaar voltooi om te bepaal hoeveel inligting in die self-studie handleiding bemeester is. Sodra die toets geslaag is kon die student les 1 selekteer 'n Skematiese voorstelling is vir elke les ontwerp om die studente te help om hulleself te oriënteer.

Die inligting wat deur beide groepe bestudeer is, is in die konteks van "Operasie Naguil", 'n interaktiewe praktiese opdrag, geplaas. Die RGO groep het 'n rekenaar as 'n riglyn gehad wat getekstureerde kaarte en moontlike antwoorde verskaf het.

Drie toetse is gebruik om die studente mee te evalueer en data aangaande hulle vordering te verky. Die studente is nie ingelig oor die toetse nie aangesien die navorser hulle natuurlike leer en retensie van kennis wou toets en nie kennis verkry a.g.v. tyd spandeer aan studie nie.

Die variansie-ontleding (ANOVA) het aangedui dat die twee groepe se kaartleeskennis aanvanklik nie statisties beduidend ($p>,05$) verskil het nie. Die gemiddelde toetspersentasie vanaf die vooraf-toets tot die eerste na-toets (leer) het getoon dat die klasgroep met 15,2% en die RGO groep met 19 % verbeter

het. Die eerste hipotese het getoets of RGO tot 'n vebetering in leer en retensie sal lei teenoor traditionele klasmetodes. Die verskil tussen die klas en RGO gemiddeld vir na-toets 1 (leer) was statisties onbeduidend (p>,05).

'n Vergelyking van die gemiddelds van die tweede na-toets (retensie) het ook nie 'n statisties beduidende verskil getoon nie (p>,05). Die studie slaag dus nie daarin om te bewys dat RGO tot beter retensie van kaartleeskennis in teenstelling met konvensionele klasonderrig lei nie.

Die resultate suggereer dat dit raadsaam mag wees om klasonderrig te kombineer met RGO. Tydens die voltooiing van die missies het die studente 'n neiging getoon om vanself groepe te vorm om die vrae te voltooi. As nuwe inligting beter verstaan word deur in groepe saam te werk (groeplede leer by mekaar), kan dit dus aanbeveel word dat die RGO kaartleeskursus gekombineer word met meer besprekingsgroepe.

Ten slotte word daar nie bevind dat RGO 'n beter opleidingstegniek vir die onderrig van kaartleestegniek is nie. Verskeie bronne dui wel daarop dat RGO 'n betekenisvolle bydrae tot die leerondervinding kan lewer. Dus, met verdere verbetering van die program, sou RGO wel moontlik kon bydra tot die onderrig van kaartlees-bevoegdhede.

For my dad, who will move heaven and earth for me. I love you.

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CHAPTER 1

Introduction

The South African National Defence Force's (SANDF) primary reason for existence is to protect the country against external military aggression. At an international level, the SANDF strives to achieve territorial integrity and political independence of the state. As a member of the international community, the SANDF will also assist in international peace operations (Republic of South Africa, 1995). On a local level, secondary functions include disaster relief, provision of emergency services, search and rescue, evacuation of South African citizens from high threat areas, efforts to restrict cross-border crime, protection of maritime and other natural resources, social-economic upliftment, and regional defence co-operation.

The goals of the SANDF include the provision of conditions in which citizens can live in freedom, peace, and safety. This also includes the protection of human rights. Internally, the SANDF strives to integrate employees through training, making the military more loyal to the state and less subject to regional ethnic, or personal interests (RSA, 1995).

Rädel (in Rädel and Reynolds, 1988) states that any business or organisation attempts to invest minimal resources into an economic action, whilst to achieve maximum gain. It is also necessary for a company or organisation to calculate the return on invested capital. Van der Meulen (in Rädel and Reynolds, 1988) defines profitability as the profit made in a certain period, shown as a percentage of the capital invested in that period to generate this profit. The concept of profitability in a non-profit organisation may be expressed in terms of the value added, based on the capital invested. Even though the SANDF is a non-profit organisation, it is still of the utmost importance that it capitalises on its means and resources to maintain maximum added value. The same principle can be

found in Sutermeister (1976), where the high correlation between profitability and productivity is emphasised. The success of an organisation depends on the productivity level within the organisation or company. Therefore, it is imperative for any organisation to improve on productivity. This can be seen as the organisations main goal. The two general factors that determine productivity are the technological resources and the performance of the human resources of the organisation (Sutermeister 1976).

Human Resource Management has as its objective the maximization of the contributions that employees make to productivity. Boudreau (1991) identifies two types of human resource interventions. The first type of intervention could be described as employee flow interventions, and include all activities that adjust the composition of the work force through the regulation of employee movement in, through and out of the organisation. Employee movement refers to promotion, appointing new employees, and so forth. The second type of intervention could be termed employee stocks interventions, and consist of programmes that are implemented to change the characteristics of existing employees in a manner that should express itself in improved work performance.

The goal of these latter type programmes is to adjust the behaviour of employees in an attempt to achieve more valuable organisational outcomes. Through the optimisation of human resources, an organisation may attain higher levels of profitability. An important activity aimed at improving the quality of existing employees in their current positions falls in the field of Human Resource Development. Employee development refers to human resource activities that are designed to enhance the value of employees (Milkovich and Boudreau, 1994).

Training forms an integral part of Human Resource Development. This is an important activity within the SANDF as a means of integrating different military forces. Each of these groups has different educational and training backgrounds,

and it is therefore important to develop a training system that will incorporate all members of the SANDF, irrespectively of their previous education (RSA, 1995).

Stable civil-military relations are largely dependent on the professionalism of the armed forces. Education and training programmes within the SANDF are a cardinal means of building and maintaining a high level of professionalism. In this regard the Interim Constitution stated that all members of SANDF should be properly trained in order to comply with international standards of competency. At the heart of training is the preparation of officers and other ranks to fulfil the SANDF's primary mission of defence against external military aggression. In addition, special training programmes are required to standardise procedures following the integration of armies, to facilitate an equal opportunity programme and upgrade the skills of black soldiers, to meet the particular needs of an all-volunteer force, and to prepare for involvement in international peace operations (RSA, 1995).

Although South Africa is not confronted by any anticipated external military threat, it is still necessary to maintain a core defence capability (RSA, 1995). A large permanent force may also not be necessary in time of peace. However, there is a need for a large part-time force that will consist of personnel who serve on an annual basis for short periods of time. To maintain a high-level of professionalism, a broad spectrum of training techniques exist, ranging from lectures to simulated military exercises. One of the additions to the Human Recourse Management repertoire of training techniques is the computer. Thus far this technology has not been widely applied to the teaching of map reading.

Map reading forms an integral part of every soldier's training. Map reading and interpretation is an important competency for senior personnel who are responsible for development of mission strategies. In order to do so they need to deploy troops in a manner that will benefit the mission, but the deployment strategies must be in accordance with the accessibility of the terrain. Field troops

must be able to interpret these commands and execute them in an unfamiliar terrain. They are required to react correctly and immediately in order to provide feedback to the command centre. If the troops are not able to interpret the information they receive and execute it in a 3D environment, it may have various consequences. This may include not reaching the target, getting lost, and not reacting in the required timeframe.

Senior military personnel recently reported a noticeable difficulty among troops to interpret maps (Personal communication, Col. Retief, 2000). Although all troops are exposed to map reading during basic training, they do not frequently work with maps in the subsequent period following the basic training. They do not practice their map reading skills continuously, and when they do need the skill during planning and execution of a battle, they have difficulty in transferring their 2D knowledge of maps to the 3D reality. Therefore a way needed to be found that both addressed the problem of troops not being able to make the 2D-3D translation and the fact that they did not work with maps frequently enough to practice that skill.

One solution to this problem seems to be Computer Based Training (CBT). CBT caters for different types of learners, can be interactive, and may encourage an explorative way of learning. It can also be used more than once, often without the need of an instructor. Troops can practice map-reading techniques more than once, even when they do not use a map in their day-to-day programme. Besides, CBT can be used for teaching almost anything, from mission planning and rehearsal, to the reading of maps. The advantages of CBT over other training methods will be discussed in Chapter 2.

The ability to read and interpret a 2D map that models a 3D world seems to be a prerequisite for the effective use of maps in the field. CBT could be an effective training technique in the development of this ability. The technique, however, requires a far greater investment in terms of money, time, and expertise than

traditional classroom based training. The implementation of CBT for the training of map reading would thus only make sense, if the monitory worth of the increase in map reading competency achieved over conventional techniques, exceeds the worth of the resources invested to achieve this improvement. The objective of this study therefore is to determine whether a significant improvement in map reading competency can be achieved by CBT, over traditional classroom based lectures when teaching students how to read a 2D map. If a significant difference in knowledge acquisition and retention could be demonstrated, it would be viable to explore this teaching method further in terms of its utility. If CBT does in fact produce a significant improvement in the map-reading competency of soldiers over the levels typically achieved by traditional training techniques, the effectiveness of CBT will probably differ across participants. The technique will probably produce better results for some learners than others. If the technique is to be utilized effectively, the factors that determine these differences need to be understood. The secondary objective of this study will thus be to determine which student/learner centred factors influence the effectiveness of CBT.

To achieve these objectives, certain prerequisites had to be met. A new training programme needed to be designed. The programme was developed in two equivalent formats, one for a traditional lecture-driven class scenario, and the other in a CBT format. The CBT programme required screen-by-screen storyboards for every scenario. Several manuals also needed to be designed. These include self-study manuals, class manuals for both trainer and student, and CBT manuals also for both trainer and student. To place the training in context, missions were designed so that students could apply their new knowledge in simulated real life situations. This required both a design on paper and an electronic version. To evaluate the performance of the students, a pre-test and two post-tests had to be developed. Questionnaires were also required and therefore developed to evaluate participants.

This thesis is consists of seven Chapters. Chapter two, three, and four consists of the literature study, an explanation of the research design and an explanation of the design of the course. Chapter five and six deals with the presentation of the programme, student evaluation and the empirical research results. Chapter seven will discuss conclusions and recommendations. All the Appendixes (i.e. manuals, evaluation, CBT programme) are available on the two compact discs that are included.

To access Appendix 1-5 and 7-8 insert CD 1 into the computer's CD-Rom drive. On the Windows taskbar, click Start, and then choose Run. In the Run box, type z:\index.htm (substitute your CD-Rom drive letter for the "z").

Insert CD 2 into the computer's CD-Rom drive to access Appendix 6. Click on Start and then Run. Select Browse, and select the CD-Rom drive, MapReading and then Setup. Press OK. Follow the instruction to install the programme. The default installation installs everything. Do not change the default path (c:\Projects\MapReading). Approximately 200MB is needed on the C drive. Install Shockwave. Copy the 'Xtras' directory on the CD to the 'system32\Macromed\shockwave 8\Xtras'.

To examine the 2D missions login as Administrator, force number CBS. Select administrator, student, and double click on e. Make sure that Virtual Reality is not selected. Click on OK. To access the programme login as e, force number e. To examine the 3D virtual reality missions follow the same procedures and ensure that the Virtual Reality checkbox has been checked.

Full instructions to use this CD are also available in the ReadMe file.

CHAPTER 2

Literature Study

Various forms of training are available. Traditionally classroom-based training is assumed to be the most cost effective, and is therefore commonly used. In situations where practical knowledge is required, on-the-job training is thought to be the ideal method. However, using alternative or complementary methods can beneficially enhance a training situation. Alternative training techniques can add to the quality of the training programme, the acquisition of knowledge, and the retention of the new material learned.

Complimentary training instruments include slide shows, videos, physical examples, simulation, and many more. Computer Based Training (CBT) may contribute to the acquisition of knowledge when students need to visualise concepts. CBT incorporates principles from the Component Display Theory and Constructivism, which suggest that the incorporation of CBT in map reading training programmes might result in superior map reading competencies.

The literature overview will attempt to explain why CBT should enhance the learning of the type of new material typically encountered in military map reading programmes. Constructivism (Casa, Fialho and Maia, 1997) and the Component Display Theory (Merril, 1998) will be used to argue that CBT incorporates the critical learning principles or prerequisites that contributes to effective learning. The literature overview will secondly attempt to establish when CBT would be applicable and how it can be of use in the teaching of map reading.

2.1 PRINCIPLES OF ADULT LEARNING

There are some principles regarding the training of adults that should be adhered to irrespective of the training technique. Adults are people with experience and therefore have information regarding a subject that they can contribute to the class (Knowles, 1986; Zemke and Zemke, 1984). Because adults have previous experience they relate new knowledge to this previously learned information and experiences (Knowles, 1986). They also have different learning styles that will be discussed in detail in section 2.5. In addition adults tend to have a problem-centred orientation to learning and have the need to apply new knowledge as soon as possible in the working environment (Knowles, 1986). Most important, adults' self-esteem and ego are at risk in a classroom environment that is not perceived as safe or supportive (Billington, 2000; Zemke and Zemke, 1984). Students will not ask questions or participate in learning if they are afraid of being put down or ridiculed.

If the above-mentioned principles are not adhered to, an environment is created that is not optimal for adult learners to learn new information. Unnecessary stress is created when adults do not feel secure and respected in the training situation. Adults are also more critical and will loose interest in a course that is not well designed or relevant to their career or immediate environment.

2.2 DEFINITION OF COMPUTER BASED TRAINING

CBT refers to a form of training where the student interacts primarily with a computer. Other supplemental materials such as manuals, discussions, etc. may accompany the CBT programme. Gery (1996) defines CBT as an "interactive learning experience" where the learner must respond to stimuli provided by the computer. The computer system will then analyse the responses and provide feedback.

Different types of CBT exist. Janicak (1999) classifies the various types of CBT programmes as follows:

- Computer-assisted instruction provides drill and practice.
- Computer-managed instruction evaluates test performance, guides the student to appropriate instructional resources, and tracks progress.
- Computer-enriched instruction in which the computer serves as a simulator or programming device.

2.2.1 Advantages of CBT

According to Chappel (date unknown) there are several advantages when using CBT.

- CBT is self-paced; therefore students can complete a section at their own pace and review a section if needed. Adults prefer more control and CBT can provide this.
- If a network is used, CBT provides for flexible schedules.
- CBT is cost effective, since training can be provided on site. This eliminates the cost of travelling and accommodation for several students.
- Some studies found that CBT programmes may reduce training time.
- As CBT engages multiple senses, knowledge retention increases.
- As CBT is a non-human interface, the message is always consistent.
- Student's responses can be measured.
- A programme can be customised to fulfil the needs of a specific company.

2.2.2 Difficulties with CBT

The following points refer to assumed difficulties with CBT, rather than disadvantages of CBT. Most of these difficulties, as listed by Chappel (date unknown), can be overcome.

- Students prefer an actual person teaching them.
- For new employees the training environment of the company may seem impersonal.
- There may be a lack of student interaction.
- Depending on the number of employees and type of programme, CBT may be less cost-effective.
- Lack of review and remediation.
- If poorly designed, the programme may not provide enough feedback.
- It is difficult for the employer to automatically determine what the student has learned.
- Product quality.
- More research is needed to compare CBT effectiveness to traditional classroom instruction.

The above-mentioned advantages and difficulties can also be used as a base to argue that traditional classroom training may or may not be successful. In a classroom there is not enough time to afford each student the opportunity to learn at his/her own pace. Employees also need to take time off from work to attend these classes. It is also time consuming travelling to a training facility that is not on-site. Even when training ends early, employees do not return to work. Furthermore, travelling and accommodation also ads to training expenses. As stated, CBT engages in multiple senses. This is also possible in a classroom situation, but only with enthusiasm and extra work by the presenter. This also raises the fact that presenters are not consistent in presenting the material. On the other hand, technology may seem impersonal, when employees prefer

human interaction with a lecturer. The quality of the programme may be problematic in both training methods.

2.3 THEORETICAL BASE FOR COMPUTER BASED TRAINING: CONSTRUCTIVISM AND COMPONENT DISPLAY THEORY

Constructivism is based on Piaget's theory of "genetic epistemology", where a child builds a model of the world through his/her cognitive stages of development (Casa, Fialho and Maia, 1997). Knowledge is actively constructed by the learner, not passively received from the environment (Dougiamas, 1998). This implies that the learner is actively involved in the learning processes, and does not sit passive and listens to a lecturer.

CBT can be a constructive environment where the user can create, manipulate, and edit information. In manipulating this world, users attribute meaning to information by personalising it (Osber, Winn, Rose, Hollander, Hoffman and Char, 1997). Learning is the construction of knowledge, and is unique to every individual. Because classroom instruction is more structured, it provides less of a constructive environment for an individual learner.

David Merril (1998) focused on this uniqueness of the individual and developed the Component Display Theory. In this theory, which focuses on a single idea or objective at a time, the best combination of instructional strategies is created to produce a particular learning outcome. The theory suggests that for a particular objective and learner, there is a unique combination of presentation forms that result in the most effective learning experience.

The component display theory focuses on two primary aspects, namely performance and content, and can be summarised in the following matrix (Figure 2.1):

PERFORMANCE	**CONTENT**			
Find				
Use				
Generality				
Remember				
	Fact	Concept	Procedure	Principle

Figure 2.1 Component Display Theory: Performance/Content Matrix

(Anderton, Parry, and Twitchell, 1990)

Before this theory can be applied, a task analysis should be preformed. It is important to determine in which tasks competence need to be acquired, the complexity of the level of performance required, and at what level of generality the learner should be able to perform the task. Figure 2.1 demonstrates how information needed to achieve the desired performance (content), could be divided into facts, concepts, procedure, and principles. For each category of content, the appropriate form of performance (labelled as find, use, generality, remember) can be selected.

In step two the primary presentation forms for the content should be examined. This included rules, examples, recall, and practice, and are dependent on the information and performance level needed.

If the steps are compared with the matrix, a partial example of the teaching of map reading can be explained in the following manner:

PERFORMANCE	CONTENT			
Find			X	X
Use		X	X	X
Generality				X
Remember	X	X	X	X
	Fact	Concept	Procedure	Principle

Figure 2.2 Application of the Component Display Theory

In Figure 2.2 a student would be required to remember (performance criteria) certain facts (type of contents), but when concepts are explained he/she should also know how to use them. When a procedure is studied, the student must also know where to find it. It is also necessary to know how to generalise a principle.

Step three, refers to the examination of the secondary presentation forms. These are outlined specific and include the prerequisites, objectives, help, mnemonics, and feedback. In a CBT programme attention could be drawn to important information by arrows, different colours, etc. It is also possible to change the representation of information through diagrams or Tables for example. Most important, the student should receive feedback to determine if he/she understands the information correctly. Continuous feedback is a feature that can be incorporated into a CBT programme without difficulty.

This theory is applied most effectively when both primary and secondary presentation forms are included in the actual presentation of learning material. This allows the learner to select his/her own instructional strategies in terms of content and presentation components. The ideal CBT programme will include the objective, the information, examples, different forms of practice, and

feedback. This will differ from the normal classroom or generic CBT, in the sense that the learner has enough control over the programme to select the number of examples or exercises needed to master the information.

2.4 WHEN TO USE COMPUTER BASED TRAINING

McElligott (1997) states that it is necessary to conduct a feasibility study before deciding to use CBT as a training intervention. First of all CBT may become a expensive intervention if for example a new programme needs to be developed, if insufficient resources exist, or if there are not enough students to justify the project. Therefore it is important to determine before hand if CBT is suitable or not, for any given training situation. Four types of feasibility must be explored, namely instructional, organisational, technical, and economic feasibility.

2.4.1 Instructional Feasibility

Instructional feasibility refers to the variety of students, e.g. their different levels of experience, and the nature and importance of the information to be studied. When students are at different entry levels, training must be standardised and be ready on demand, therefore CBT is more desirable. Table 2.1 indicates the aspects that need to be considered to determine instructional feasibility. When most of the answers prove to be positive, CBT can be considered instructionally feasible.

Table 2.1 Instructional Feasibility Checklist

Instructional Feasibility	*Yes*	*No*
1. Is the training course likely to be used long enough to be a good candidate for CBT?		
2. Does the total student volume justify CBT?		
3. Is the job performance so critical that a high degree of control over training effectiveness is needed?		
4. Are there pedagogical requirement for interactive instruction (e.g. dynamic graphics, immediate feedback)?		
5. Are there large differences in student entry levels that necessitate individualised instruction?		
6. Is the training environment an extension of the job environment (e.g. do both use computers)?		
7. Is there a strong need for standardised training (particularly at distributed training locations)?		
8. Is there a strong need for on-demand training (i.e. training available whenever and wherever needed)?		
9. Does the training involve expensive equipment or scarce experts?		
10. Is the training relatively independent of human interaction?		
11. Is the present training programme and materials competency-based?		
12. Are there aspects of the current training programme that can be done well via CBT?		

(Kearsley in McElligott, 1997)

2.4.2 Organisational Feasibility

The organisational feasibility checklist attempt to determine if an organisation will be able to develop and maintain a CBT intervention. Table 2.2 highlights the organisational prerequisites that have to be satisfied for CBT to succeed. Management, trainers, and staff should be positive towards CBT. Resources and expertise required to develop, implement, and test the new programme must be available. Finally, the organisation must be ready to implement the changes that accompany the new technology. There will always be problems with

implementing new technology in an organisation. These should be strictly monitored, as a single factor could prevent successful implementation of CBT.

Table 2.2 Organisational Feasibility Checklist

Organisational Feasibility	*Yes*	*No*
1. Are the systems personnel needed to design, develop implement, operate and maintain a CBT system available?		
2. Are the instructional designers/developers needed to create and maintain CBT materials available?		
3. Is the necessary instructional programming expertise available to implement, test, and debug CBT programmes?		
4. Are the necessary administrative personnel available to plan, supervise and manage CBT activities and do they have appropriate expertise?		
5. Are the reactions of the training staff and students likely to be positive toward CBT?		
6. Are the attitudes of the key decision makers positive toward CBT?		
7. Is the application free of any organisational conflicts likely to jeopardise the success of CBT?		
8. Is interest in and support for the use of CBT widespread rather than limited to a few individuals?		
9. Are the expectations of the training staff or decision makers regarding the benefits of CBT reasonable?		
10. Is the training system and organisation flexible enough to accommodate disruption caused by the implementation and testing of CBT?		
11. Does a formal mechanism exist in the organisation for the modification of procedures or policies needed to accommodate changes required for CBT?		
12. Is it clear which organisational entity will have responsibility and authority for implementing and operating the CBT system?		

(Kearsley in McElligott, 1997)

2.4.3 Technical Feasibility

The technical checklist monitors whether the functional capabilities necessary for the CBT application are available. The sophistication of the hardware required would depend on the complexity of the CBT programme. If this is not currently available within the organisation, the extra cost incurred in purchasing the required systems could prevent the development of the new programme. When inadequate hardware is used, reaction time of the programme may be slow, or graphics may not be displayed correctly. This can cause frustration among users that could influence their learning experience negatively.

Table 2.3 Technical Feasibility Checklist

Technical Feasibility	*Yes*	*No*
1. Do available systems/terminals provide the kind of display, input and output capabilities required?		
2. Is the necessary processing capability available (e.g. bytes, RAM)?		
3. Is the necessary offline storage capacity (for lesson material and student records) available?		
4. Are the kinds of communications capabilities needed available?		
5. Is suitable software/courseware needed available?		
6. Can a system support the number of simultaneous users expected at peak loads?		
7. Will average system response time be acceptable?		
8. Has acceptable system reliability and service been demonstrated?		
9. If the system is to be used concurrently for other applications, is CBT free of adverse effects on other applications or vice versa?		
10. Have other technological alternatives that would have a lesser impact on resources needed been considered?		

(Kearsley in McElligott, 1997)

2.4.4 Economical Feasibility

The final checklist refers to the cost and benefits such an intervention will bring about. It is important to determine the full extend of the investment required. It will also be necessary to estimate the return on investment. Proving that training will add monetary value to an organisation is necessary for any training department, as profitability is the central objective of any organisation, and consequently all organisational endeavours (including human resource development) should be evaluated in terms of their contribution to this objective. This burden rests especially heavily upon training departments since they are not traditionally seen as significant contributors to organisational profitability, and hence quite often, one of the first departments where investments are scaled down.

Table 2.4 Economical Feasibility Checklist

Economical Feasibility	*Yes*	*No*
1. Are the total costs (including instructors, administration, facilities, equipment, materials, student ravel etc.) for the existing training programme known?		
2. Are the total development costs for the proposed CBT materials (including design, development, programming, evaluation) known?		
3. Are the total delivery costs or the proposed CBT system (including hardware acquisition, system operators, administration, facilities, offline materials, etc.) known?		
4. Will the use of CBT result in annual of life cycle cost saving over the existing training?		
5. Will the use of CBT result in value-added benefits over the existing training that can be quantified?		
6. Are assumptions underlying the cost analyses about the throughput or total utilisation of CBT reasonable?		
7. Are the immediate or total cost of CBT tolerable for the organisation?		
8. Will the organisation fund the start-up costs at a level that is		

sufficient and necessary to assure a reasonable chance of success?		
9. Will the procurement process allow the CBT system to be acquired in the timeframe needed?		

(Kearsley in McElligott, 1997)

2.4.5 Adam's Computer Based Training Decision Aid

Adams (in McElligott, 1997) developed a decision aid to assist organisations in determining if a particular training application is suitable for CBT. Table 2.5 presents a scoring system where a value between 135 and 200 indicates that CBT may be feasible. A score above 200 indicates that CBT is definitely an appropriate intervention to use.

The fist section deals with the number of students, distance from training site, frequency of updates, and the time available to develop a new programme. Section two deals with the learning styles, preference, and abilities of the students. The third and fourth sections provide a summary of the four feasibility checklists discussed previously.

Table 2.5 Adam's CBT Decision Aid

COMPUTER BASED TRAINING DECISION AID		
CONSIDERATION	**INSTRUCTIONS**	**POINTS**
Number of learners	If fewer than 50	0
	50 to 100	5
	More than 100	10
Number of preferred training sites	I learners are at	
	One site	0
	Two to five sites	5
	More that five sites	10
Distance of learners from existing training site	If the bringing the average learner to an existing training site	

	Does not require overnight stay	0	
	Does require overnight stay	5	
	Requires many overnight stays	10	
Number of times programme will be offered	Once	0	
	2 to 5 times	3	
	6 to 19 times	5	
	20 times or more	10	
Frequency of updates	If changes/updates will be needed		
	Every three months or less	0	
	Between three and six months	5	
	Six months or more	10	
Development time available	If training must be available in		
	Less than three months	5	
	Three to six months	10	
	Six months or more	10	
Subtotal			
Preferred learning style	If learners prefer		
	Group learning	0	
	Independent learning	10	
Preferred training schedule	If it is more appropriate to		
	Set training schedules	3	
	Allow learners to set schedules	10	
Current computer proficiency	If learners		
	Do not know how to use a computer and do not need a computer for their job	0	
	Do not know how to use a computer and do need a computer for their job	5	
	Know how to use a computer	10	

Current learner skill level	If learners		
	All have the same skill level	5	
	Have widely varying skill levels	10	
Need for individualised remediation	If learners probably		
	Won't need remediation	5	
	Will need remediation	10	
Consistency	If consistency of instruction is		
	Not important	0	
	Somewhat important	5	
	Very important	10	
Need for performance tracking	If performance tracking across multiple courses or modules is		
	Not needed	0	
	Desirable	5	
	Required	10	
Content	If skills are		
	Interpersonal	5	
	Technical	10	
Subtotal			
Content already available on CBT	If CBT programme		
	Must be developed to meet requirements	0	
	Can be purchased and modified to meet requirements	5	
	Can be purchased for use without modification	10	
Management's past experience with CBT	If past experience with CBT was		
	Not favourable	0	
	Neutral	5	
	Very favourable	10	
General view of technology	If management view computer technology as		

	Awful	0
	A necessary evil	5
	Great	10
Budgeting scheme	For cost comparisons, if development costs	
	Are separated from costs of delivery	0
	Are included with delivery costs	10
Availability of hardware at learner site	If hardware at learner site is	
	Not available	0
	Available but has to be upgraded	5
	Available	10
Cash flow	If cash flow is	
	Slow	0
	OK	5
	Good	10
Management's perception of person making recommendation	If person making recommendation	
	Has a poor track record	0
	Has a great track record	10
Availability and skills of project management staff	If staff can	
	Not manage a CBT project	0
	Manage project	10
Subtotal		
Availability of production hardware	If production hardware is	
	Not available	0
	Available but has to be upgraded	5
	Not needed	10
	Available	10
Availability of knowledge of CBT design and authoring language	If the staff	
	Do not know anything about authoring	0
	Will buy of-the-shelf CBT	5
	Can design and author CBT	10

Availability of content experts	If content questions must be answered and experts		
	Cannot be made available	0	
	Can be made available	10	
Use of existing trainers	If trainers now on staff		
	Will no longer be needed	0	
	Can be transferred to new positions	5	
	Can be used on CBT projects.	10	
Subtotal			
TOTAL			

(Adams in McElligott, 1997)

2.5 LEARNING IN COMPUTER BASED TRAINING

The notion or concept of learning derives from observations of enduring change in the behaviour of individuals that appears to result from environmental experiences (Wilhite and Payne, 1992). All learners, however, do not interact in the same way with their environment when constructing meaning from their environmental experiences. Learning styles refer to the preferred manner in which a person acquire, retains, and retrieve information to learn new material (Felder and Henriques, 1995).

Learning styles need to be taken into consideration when deciding on an appropriate training technique, because training techniques differ in the extent to which they accommodate the various training styles. Failure to accommodate a learner's preferred training style will result in a discrepancy between the learning styles of the students and the teaching style of the instructor. This could lead to students not being attentive, scoring low grades in tests, and becoming demoralised because it seems that they are not able to master the subject. This

may also reflect negatively on the instructor, who may question his or her own abilities (Felder and Henriques, 1995).

There are a number of alternative learning styles:

- Verbal learners: Learn well from books and lectures.
- Visual learners: Learn best form pictures, graphs and movies.
- Passive learners: Prefer lectures as the medium of instruction.
- Active learners: Prefer to partake in activities, e.g. workshops.
- Sequential learners: Learn new information step by step and form a partial understanding from incomplete instruction.
- Global learners: Need all the facts before any details have meaning (Bell and Fogler, 1996).

Traditional teaching includes verbal, passive, and sequential mediums of instruction. Unfortunately, this is only applicable to a small portion of students. Although Bell and Fogler (1996) specifically analysed a Virtual Reality based training system, some of their conclusions may well be applicable to CBT as well. CBT can be highly visual (for visual learners), but because a narrative track can be followed, it also addresses the needs of the verbal learner. Active learners will also benefit, because CBT can be designed to be highly interactive. It is also of benefit for the global learner, because it is easy to see how individual concepts and details fit together. It can thus be seen that the theory on learning styles, and the previously referred to Component Display Theory (section 2.2), merge to support the notion that CBT could make a valuable contribution to the teaching of learning material. It could be argued that the material typically covered in military map reading courses falls in the category of material that lends itself to CBT.

A learning style can therefore be seen as the manner in which a person chooses to attend to certain information. This leads to realising the importance and role that attention plays in the learning process. Broadbent (in Wilhite and Payne, 1992) developed an information processing system in 1958. This was the first

research done on man's ability to focus attention selectively. He suggested that non-attended channels of information are in some sense blocked or filtered, so as to allow for analysis of attended information. With regards to memory, Broadbent (Wilhite and Payne, 1992) explained that information arriving at the senses, is maintained briefly in a short-term memory store and that certain information in the short-term memory will be selected for analysis - that is, will be allowed to pass through a selective filter into a limited capacity channel. Once in the limited capacity channel, the input is fully perceived and is available for a variety of mental operations, including transfer to a store of past events. This theory provides a further rational for using interactive CBT as a training instrument. The user may become to such an extent immersed in the computer environment that all his/her senses are applied to the subject matter. The disturbance caused by external stimuli are thereby to a large extent eliminated, and therefore the brain need not attend to the filtering of non-relevant channels of information.

Learning is best facilitated by direct, first-hand *experience*, which also provides the best long-term retention rate. Thorndike (in Wilhite and Payne, 1992) proposed in his Law of Effect, that when a satisfying state of affairs becomes associated with a specific response in a given situation, it would more likely recur when that situation is again encountered. Individuals learn things in relation to their environment. If an individual encounters the same environment, certain information will be recollected (Lanier, 1992). The computer can simulate a scenario that is similar to the real situation, especially were the planning of a task is concerned. A traditional classroom situation is far removed from an actual working environment, unless a specific scenario is simulated. In a lecture situation, attention may be limited; therefore retention is limited (Mihall and Belletti, 1999).

Another important prerequisite for successful learning is *repetition*. In a classroom situation time is limited and a lecturer does not have time to repeat

information continually. If a lecturer teaches more than one class, the same information could be presented in a different manner. This means that not all students receive the exact same information, and sometimes there may even be a difference in quality. A CBT programme can repeat the same information without tiring. It is important to realise that CBT is not meant to replace traditional methods of training, but only to enhance the learning experience, thus providing the student with a constructive learning environment. CBT appeals to almost all the senses of the learner through sight, sound, colour, motion, and feedback, that will contribute to the learning and retention (Bell and Fogler, 1996).

Visualisation is another prerequisite for successful learning (Ferrington and Loge, 1992). Visualisation allows the user to see links and associations that would otherwise be problematical to recognise and grasp. If applied to CBT, abstract concepts can be graphically visualised in the programme, thus providing the ideal learning tool to facilitate the visualisation of complex material. It is possible to use visualisation tools in a traditional classroom situation, however an example of molecules interacting could be difficult to reconstruct in a classroom. Visibility of the examples may also be difficult in a class with a large number of students (Mihall and Belletti, 1999).

2.6. APPLICATION OF COMPUTER BASED TRAINING TO MAP READING

Visual representation of spatial information through maps has three main functions:

- Recording and storing information.
- A means of analysing locational distributions and spatial patterns.
- A method of presenting information and communicating findings.

For optimal effectiveness, knowledge of basic principles of cartographic communication and map design is essential. The use of maps to communicate

certain information in the military is of extreme importance. In any mission soldiers must be able to find their way through the use of 2D maps. Primarily, in the military contexts, maps are also used during planning and control of battles and operations.

2D maps are used to convey spatial patterns, distributions, and relationships. When using a 2D map it is difficult for users to visualise the 3D physical landscape and how the two-dimensional information on the map relates to the physical reality it represents, because spatial thinking abilities are not well developed (McClellan, 1994). The best way to understand a map is to experience the map and the environment it represents simultaneously. This however, is basically impossible due to financial considerations. A possible aid in the teaching and understanding of map reading is CBT. The computer can provide visuals, e.g. topographical forms. CBT does not replace the feeling of actually experiencing the genuine world, but it does create an experience that helps the user to better understand a place, people, or process. According to Benedikt (1991), when 3D graphics are added, information density is increased and it allows the user a more accurate understanding.

Because some users experience difficulty understanding how 2D contour lines represents a hill or mountain, a way must be found to teach users to visualise a 2D diagram as 3D reality. This can be accomplished through the application of a technique called "shaping by successive approximations" (Wilhite and Payne, 1992). Briggs (1996) supports this view by explaining that humans respond better to spatial, 3D images than to flat 2D text and sketches. By first reducing the task to easier steps and then reward actions that resemble those steps, the user learns the basic principles. By gradually requiring more complete performances to earn subsequent rewards, behaviour can be shaped into desired patterns. Bell and Fogler (1996) used this technique to teach chemical reaction engineers in Virtual Reality. If this method is applied to the teaching of map reading, the user will be shown a 3D picture of the area. As soon as he/she

is orientated, certain parts of the environment will disappear until only 3D line-diagrams are shown. When the user is familiarised with this, the line-diagram will be "pushed down" to a 2D picture of a traditional map. This will provide the user with the ability to see 2D maps as 3D environments in the future.

Way finding tasks in general require that the navigator be able to conceptualise the space as a whole. This is in accordance with Edward Tolman's (Wilhite and Payne, 1992) idea of a cognitive map, which suggests that the user must be able to formulate an image of the whole environment, before focusing on one small area. This is significantly different from procedural knowledge, which is defined as the sequence of actions required to follow a particular route, thus the "knowing how" (Witmer et al., 1996).

If CBT would be effective in teaching map reading, the question subsequently arises as to whether soldiers would be able to apply this knowledge when using a 2D map in an actual combat situation? According to the theory of classical conditioning this could be achieved through generalisation. Generalisation allows the "compact storage" of learned information to be transferred to "similar states" (Kaelbling, 1996). Generalisation helps an individual to respond consistently to the same object despite its changing appearance and to apply previous learning to novel situations (Wilhite and Payne, 1992). Generalisation is accommodated in CBT by teaching a student a new principle, providing him/her with different opportunities or scenarios to apply this new knowledge. This may become problematic in a traditional classroom situation were the field of study requires different practical conditions.

Schematically the two training methods, traditional classroom training and CBT, and its role in the acquisition of knowledge can be summarised in the following manner on the next page:

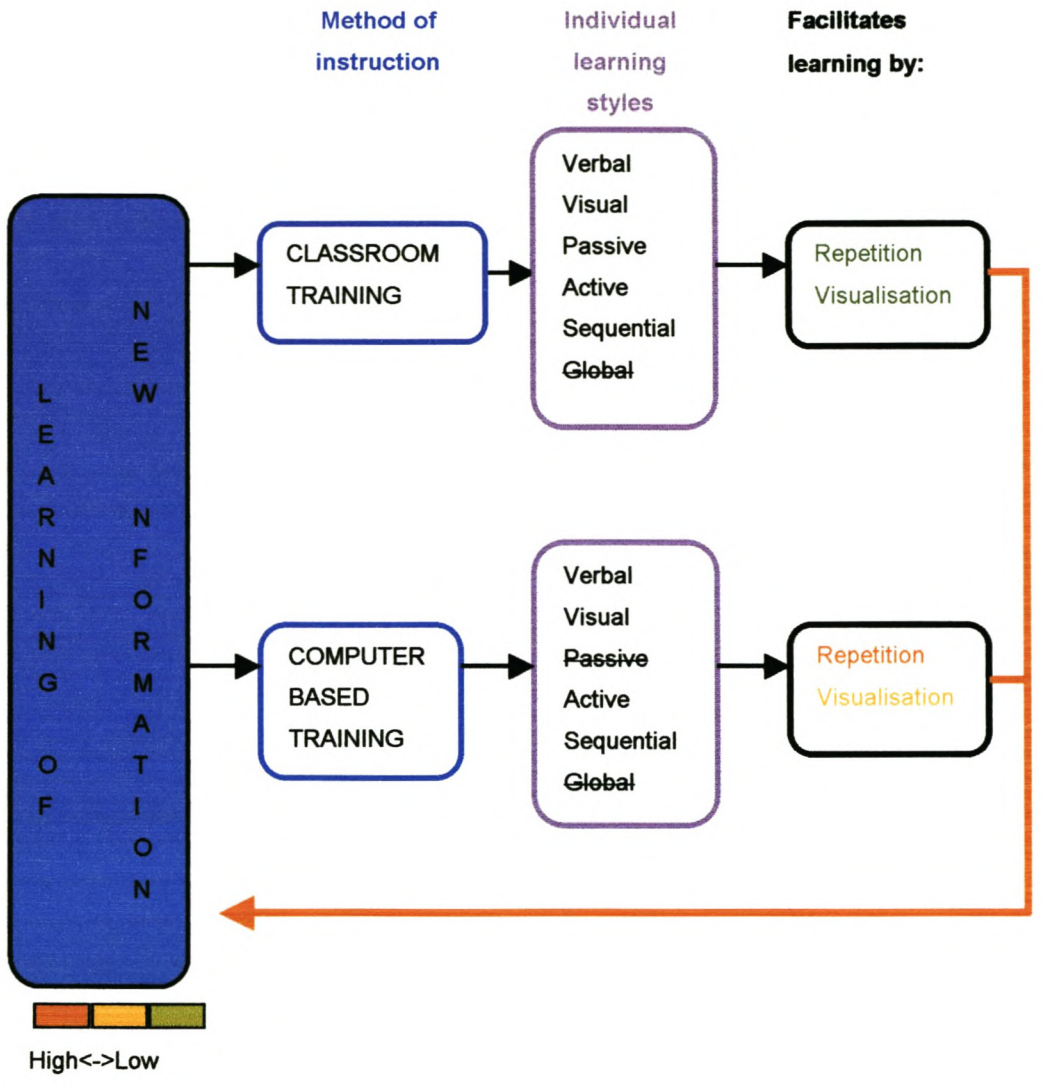

Figure 2.3 Contrasting Classroom Training and CBT

The structural model shown in Figure 2.4 summarises the literature overview in terms of the problem statement and the hypotheses that will be discussed in Chapter 3.

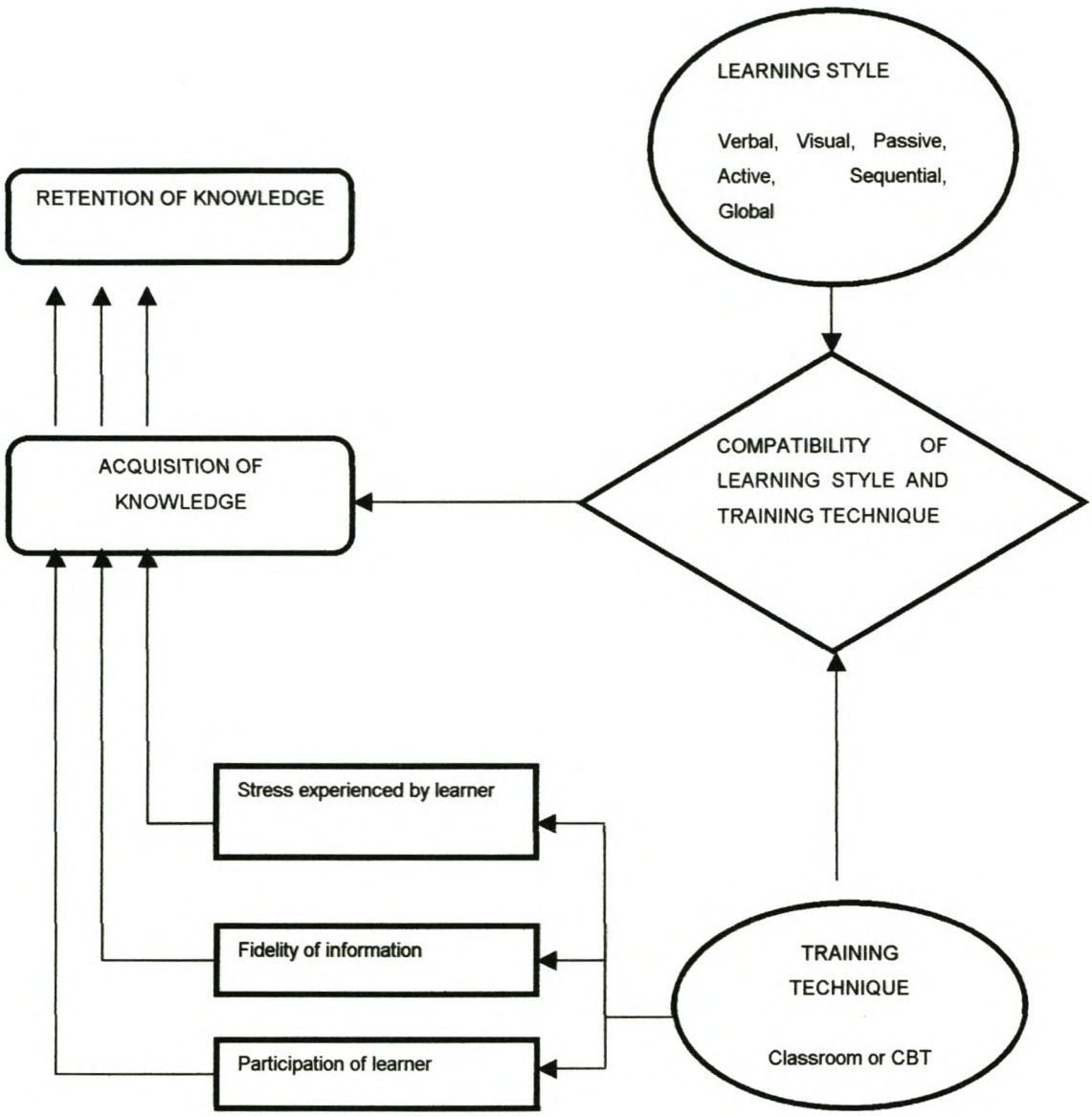

Figure 2.4 Defining the problem statement and hypotheses in terms of the literature overview

The literature overview of the relevant theory suggests that CBT should achieve greater acquisition and retention of knowledge than traditional classroom training when applied to the development of map reading competencies, because it implements the most important learning principles better than the conventional approach. This warrants further investigation into the use of CBT and whether it will improve the retention of new information.

CHAPTER 3

Methodology

3.1 PROBLEM STATEMENT

It was argued in Chapter 2 that CBT, to a greater extent than classroom training, succeeds in complying with the prerequisites for effective learning. The following formal research problem consequently arises.

In accordance with Constructivism (Casa et al, 1997) and the Component Display Theory (Merril, 1998), will training through CBT result in greater understanding and retention of new map reading related information than traditional classroom training?

3.2 HYPOTHESES

H_1: CBT enhances the acquisition of knowledge to a greater extent than traditional classroom training, when teaching users how to read a 2D map.

H_2: CBT leads to better retention of knowledge over a one month period when used to teach 2D map reading, than traditional classroom training.

H_3: The acquisition and retention of knowledge through CBT are dependent on active learner participation, perceived fidelity of representation of information, and the psychological and physical stress, experienced by the user.

3.3 RESEARCH DESIGN

Evaluative research is the application of research methods in order to produce knowledge that is useful in evaluating the effectiveness of programs. By applying an experimental design, it is possible to provide evidence of the causal effect of a test variable by controlling conditions affecting the hypothesis (Smith, 1997). The influence on the independent variable X (method of instruction) on the dependent variables Y_1 (acquisition of knowledge) and Y_2 (retention of information) can be determined by randomly allocating subjects to two groups. Each group will be exposed to a different training programme.

Figure 3.1 schematically depicts the experimental design utilised for the testing of hypotheses one and two.

Pre-test	Group	Treatment	Post-test 1		Post-test 2
T_1	(R) Control group	X_{Class}	T_2	**ONE MONTH WAITING PERIOD**	T_3
T_1	(R) Experimental group	X_{CBT}	T_2		T_3

T_1=General knowledge test on map reading.

T_2=Theoretical and practical evaluation.

T_3=Theoretical and practical evaluation.

R=Random assignment

X_{Class}=Classroom based training

X_{CBT}= Computer based training.

Figure 3.1 Research design for H_1 and H_2

The validity of hypothesis three will be tested through multiple linear regression. The researcher's inability to experimentally manipulate the independent constructs contained in hypothesis three, precludes the possibility of using an experimental design. The ex post facto correlational design used to test hypothesis three is portrayed schematically in Figure 3.2.

Y_1	X_{11}	X_{12}	X_{13}
Y_2	X_{21}	X_{22}	X_{23}
Y_3	X_{31}	X_{32}	X_{33}
Y_n	X_{n1}	X_{n2}	X_{n3}

Figure 3.2 Research design for H_3

Where: Y = learning; X_1 = perceived fidelity of representation of information; X_2 = Degree of active learner participation; X_3 = Psychological and physical stress

3.3.1 Characteristics of the sample group

The research sample consisted of 59 military personnel of the School of Armour of the SANDF at Bloemfontein. The control group consisted of 30 students and the experimental CBT group of 29 students. The mean age of the total group was 27,9 years. The groups were all male expect for one female in each group. According to rank there were: 7 Captains, 12 Corporals, 4 L/Corporals, 2 Lieutenants, 1 Major, 8 Sergeants, 23 Troops, and 2 Warrant Officers. 33,9 % of the group's first language was Afrikaans, and the rest one of the other official African languages. No one spoke English, even though it is the official policy of the SANDF to conduct all training and communication in English. In terms of education, 50 % of the students completed their senior certificate, and 32 % received further education through the SANDF. However, with regards to computer literacy only 10,2 % were of the opinion that their skills were good.

With regards to map training, all students were exposed to map reading during basic training. Even though each individual received instruction on map reading during basic training, only 25,4 % of all students use maps on a regular basis.

3.3.2 Location and setting of study

Research was conducted in Bloemfontein. The control group received class in their normal training rooms on the base. However, the CBT students had to be moved to Grey College to be trained on computers capable of accommodating the CBT programme.

3.3.3 Sampling design and procedures

Personnel of various units from the military base at Bloemfontein had been selected. A non-probability sampling procedure was used to select the sample from the personnel of the School of Armour. Due to the nature of the sampling procedure, the sample cannot be claimed to be representative of either the School of Armour or the SANDF. Personnel eligible for the course were limited to those available at that point in time. Official courses that could lead to promotion had precedence over the map reading project. Not all units could send the same number of personnel. The sample was first divided into personnel who use maps, and those who do not use maps on a regular basis. The list was then sorted according to rank and subjects were then randomly assigned to group one or two.

The control group (classroom based training) consisted of 30 subjects, and the experimental group (computer based training) consisted of 29 subjects.

3.3.4 Statistical hypothesis

Given the experimental design portrayed in Figure 3.1 hypotheses one and two will be tested statistically by testing the following two null hypotheses:

H_{01}: $\mu_{control;\ T2} = \mu_{CBT;\ T2}$

H_{02}: $\mu_{control;\ T3} = \mu_{CBT;\ T3}$

Given the design portrayed in Figure 3.2, hypothesis three will be tested statistically by testing the following two families of null hypotheses:

$H_{03\iota}$: $\rho(Y,X_\iota) = 0;\ \iota = 1,2,3$

H_{041}: $\beta[X_1] = 0 \mid \beta[X_2] \neq 0;\ \beta[X_3] \neq 0;$

H_{042}: $\beta[X_2] = 0 \mid \beta[X_1] \neq 0;\ \beta[X_3] \neq 0;$

H_{043}: $\beta[X_3] = 0 \mid \beta[X_1] \neq 0;\ \beta[X_2] \neq 0;$

Where Y = learning; X_1 = Perceived fidelity of representation of information; X_2 = Degree of active learner participation; X_3 = Psychological and physical stress.

H_{03} examines the individual effect of the presumed learner centred determinants of CBT effectiveness on learning performance. H_{04}, in contrast examines whether each presumed determinant of CBT effectiveness, significantly explains unique variance in learning performance not explained by the other effects included in the model.

3.3.5 Data collection instruments

Data were collected regarding their acquisition and retention of new map-reading knowledge through a questionnaire and a test at the end of the course. The scores were compared with a pre-test written before the students received any manuals or training. As this was not an academic evaluation of a formal course, a pass rate was not required. The test scores of the different groups were, in accordance with the research design, compared to determine which of the groups were more successful in terms of acquisition, retention, and application of their new knowledge. One month later both groups were evaluated again to

measure if there was a difference in retention of the new information learned. This period, though not optimal for the measurement of retention, was chosen for this study due to time constraints. The influences of participation, fidelity, and stress experienced by the users were measured through a questionnaire concerning the subjective training experience of the participants.

3.3.6 Validity of research design

Internal validity is only relevant in studies that try to establish a causal relationship, or that want to assess the effects of a program or intervention. The key question in internal validity is whether observed changes can be attributed to the designed program or intervention and not to influences not incorporated in the design. External validity is related to generalising, thus to what extent will a study hold true in other circumstances.

Internal and external validity are important to this study to determine to what extend CBT contributes to the teaching of map reading, and to what degree the findings can be generalised to other groups that need training in the reading of maps.

Campbell and Stanley (in Smith, 1997) state that threats to internal validity will prevent the unambiguous interpretation of the results of the experiment, and that the potential to generalise the finding will be influence by external validity of the design. Campbell and Stanley (1963) summarise their evaluation of the randomised groups design utilized in the study in Table 3.1.

Table 3.1 Sources of Invalidity

	SOURCES OF INVALIDITY											
	INTERNAL								EXTERNAL			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of selection etc.	Interaction of testing and X	Interaction of selection and X	Reactive arrangements	Multiple-X interference
Pre-test-post-test control group design	+	+	+	+	+	+	+	+	-	?	?	

+the factor is controlled; - indicates a definite weakness; ?indicates a possible source of concern

(Campbell and Stanley, 1963, p. 8)

For this study internal validity could have been compromised by *extraneous events*. Subjects may have experienced pressure from other work related engagements or they may not have been equally motivated to learn. These emotional variables could not be eliminated, but their effect could be controlled by random assignment. *Temporal effects* that needed attention were maturational effects and practice effects. This implies that students may score higher in a later test because they had more exposure and experience with the new and related material studied. To measure the retention of information there was a one-month time lapse in the study. Subjects may have performed better because they have "matured" or because they had practiced the material they were tested on. In this study, subjects were only able to "practice" the information they have received by studying the written material; therefore both groups had access to the same information. The experimental group had no further access to CBT after the initial training session. Due to the fact that

participants were randomly assigned to treatments, the research design successfully controlled maturation, testing and instrumentation.

Another factor that could have been problematic was the *group composition effect*. Individual differences may have influenced the results. Through the use of matching and random assignment, the threat of differential selection was successfully controlled.

Statistical regression is one of the most important factors that must be taken into account in determining internal validity. This is especially important when a researcher utilises a group selected on the bases of extreme pre-test scores. This, however, did not present a problem in this study, though the threat would be controlled by the chosen research design.

The objective of this study was to determine whether CBT promotes the understanding of map reading. Should the study succeed in achieving this objective the results could only be generalised to other units of observations and conditions to the extent to which the design controls poses threats to external validity.

Because of the restrictions mentioned in section 3.3.3 it was difficult to ensure a *representative sample*. Even though the sample group was selected to represent the population, subjects could still act differently because they knew they were being observed. This is known as *reactivity*, and may influence the results and not reflect a true representation of the population. Therefore, it will be difficult to generalise the results.

Another *methodological design flaw* that must be kept in mind is the familiarity of the sample group with CBT. The biographical questionnaires indicated that the majority of the sample group were not familiar with computers. To reduce

possible problems procedures were kept simple and the sample group was only required to be able to "click and drag" with the mouse.

3.3.7 Administration of the data collection instruments

A Captain of the School of Armour conducted the normal classes. He had previous experience in teaching map reading. The CBT classes were presented by a Sergeant Major, also from the School of Armour. He was familiar with both the use of computers and the teaching of map reading. The researcher compiled evaluations (written tests) with the help of Geography students from the University of Stellenbosch, and personnel of the School of Armour. The researcher was not present for the pre-test or the second evaluation.

3.3.8 Data processing procedures

Data were processed through the use of the statistical programme SPSS (SPSS, 1990). Hypotheses one and two were tested through two one-way ANOVAS. Alternatively a single one-way MANOVA (although this would introduce an additional multivariate hypothesis not previously stated) could have been used. Hypothesis three was to be tested by simple correlation analyses. Standard multiple regression analysis was to be used for hypothesis four.

CHAPTER 4

Design of the Map-reading Course

When designing a new training intervention, specific questions must be answered. These include questions about the nature of the training need, the type of technique to be used, the type of learning material that needs to be covered, identification of the students that need to be trained, training of the trainers, monitoring the implementation of the training activities, and evaluation of students and the training course.

4.1 FEASIBILITY OF USING CBT

As discussed in Chapter 2, section 2.3, there are certain decision aids available to decide when to use CBT. Using Kearsley's (in McElligott, 1997) feasibility checklists, it was concluded that CBT would be an appropriate training technique in the military context for the development of map reading competencies.

With regards to the instructional feasibility (Table 2.1, page 15) it is clear that map reading is a course that will be presented unchanged over a long period of time, as it forms part of basic training and as the nature of the basic map reading competencies required do not tend to change over time. The number of personnel also justifies this method, especially if compulsory military service would be implemented again. As many of the students in the sample group do not work with maps on a daily basis, it may seem that a basic map reading competency is not that critical. However, if these troops were ever required to go into combat, this would be an extremely important prerequisite for them to function effectively in their job. Irregular exposure to map reading also results in troops having different levels of knowledge because they do not all work with

maps on a daily basis. CBT is a training intervention that allows for students of different entry levels to all follow the same programme. As there is only one "correct way" of interpreting a map, CBT also helps to standardise training. Map reading is also a topic that can be studied without human interaction, which makes CBT a viable option.

Only two aspects lower the instructional feasibility of CBT for map reading instruction. The use of computers is not an extension of the daily job activities of soldiers, and neither would on the job training require expensive equipment.

Organisational feasibility (Table 2.2, page 16) seems very positive. However, it must be kept in mind that the evaluation of organisational feasibility was based on information obtained from the School of Armour, and not on the SANDF as a whole. Both staff and key decision makers had positive attitudes toward technologically advanced training. On the technical side two companies, namely CyberSim and Quality Training Technology, were available for programming and had the expertise to implement the programme. The success of this programme could influence the decision to implement CBT on a more widespread basis.

Table 2.3 (page 17) refers to technical feasibility. It seems that technical problems may occur if the programme is implemented on a more permanent basis. Currently the military's computer laboratory does not have a sufficient number of appropriate computers to support the proposed CBT programme. However, money is available for an upgrade of the facility. The testing of the map-reading course was conducted at Grey College, were the facility was adequate and no technical problems were experienced.

Finally, it is important for any new intervention to be economically feasible (Table 2.4, page 18). Under normal circumstances a company has a certain budget allocated for training. As the programme was offered to the military without any cost, this part of the questionnaire could not be answered based on the SANDF

training budget. The project was funded with the help of CyberSim and Quality Training Technology and other research grants. Therefore this section could not be completed in terms of the actual training budget available to the SANDF.

Chapter 2 also refers to a decision aid developed by Adams (in McElligott, 1997). This aid (Table 2.5, page 19) works on a scoring system where less than 135 indicates that CBT is not appropriate, between 135 and 200 that CBT can be viable, and above 200 indicates that CBT is particularly feasible. The decision aid was completed with this specific project at the School of Armour in mind. Four subtotals (30,48,55, and 40) were scored, totalling to 166. This indicated that CBT might be a viable option for the map reading course.

Based on the literature study and the above decision aids the developing of a new map-reading course for the School of Armour seemed to be appropriate and viable.

4.2 TRAINING NEEDS ASSESSMENT

The reason why any training intervention should be attempted, is to fill the training gap between what an employee should know and what the employee knows. Should there be a need for a training intervention, a training needs assessment must be conducted. Before a solution can be found for the deficiency in knowledge, the problems that occur must be correctly identified and diagnosed. As mentioned in Chapter 1, information was received from the military that the main problem with map reading is that soldiers have difficulty interpreting a 2D-map of a 3D world.

In order to find a solution to the problem, a task analysis needed to be done. A task analysis refers to the determination of those behaviours and skills that an employee needs to demonstrate in order to complete a task successfully. This

corresponds with step one of the Component Display Theory (Merril, 1998). The task analysis (Appendix 1) was structured in such a way that it narrowed a broad job description down to specific tasks that needed to be completed. A personal interview was conducted with a panel of military employees to determine the core competencies that a soldier needs to perform basic map reading.

The broad assignment for any soldier is to interpret the 2D-map to be able to complete a task assign to him/her in an actual situation. Specific tasks include, preparations of maps, identification of different types of maps, interpretation of scales and symbols, interpretation of the terrain, navigation tools and planning, and the updating of a map. These competencies were used to determine the basic information that had to be included in the new course.

4.3 THE TARGET GROUP AND SELECTION OF INFORMATION

Students in both groups of the research study completed a profile questionnaire. The School of Armour developed a questionnaire based on questions formulated by the researcher. This form included questions on their age, language, rank, computer literacy, use and knowledge of maps, and their career prospective. Although there were personnel of higher rank, it seemed that all had a need for training in or revision of basic map reading principles.

The School of Armour provided the information included in the course. This was based on old manuals developed in the 1980's. Some of the information had to be revised and complementary information and diagrams were included. To ensure that the revised information was correct, the new material was reviewed by staff of the School of Armour and students from the Geography Department at the University of Stellenbosch.

4.4 DESIGN PRINCIPLES

When working with adults in a training context, Knowles (1986) specifies certain characteristics of adult learners that should be taken into account when designing a training course. Facilitators should involve adult learners to a great extent in the learning process, because they are autonomous and self-directed. Furthermore, adults have a wealth of life experiences that they can contribute to the class, are more goal-oriented, definitely relevancy-oriented, focused on the practical, and finally must be shown respect.

In an attempt to comply with the above principles, a section was included in the biographical form that the students completed. They were asked if they thought the course would be relevant to them, and what they would prefer to see included in the course. At the end of each Chapter (Appendix 2, sections marked: Exercise), for both the CBT and the Class group, questions were included to provide an opportunity for discussion and contributions from the students. Both the instructors completed a prior course on adult training, and were aware of how to treat adult learners.

Fink (1999) developed five criteria that should be included when designing a new course. The first principle refers to a "higher level" of learning. In the map-reading course, "lower level" of learning was required from the students in the form of remembering definitions and formulas (Appendix 4, post-test 1, question 5 for example). This was followed by "higher level" of learning when they had to apply this knowledge to calculating, for example, gradients and intervisibility (Appendix 3 and Appendix 4, e.g. post-test 2, question 3 and 4). The second principle refers to active learning in favour of passive learning. Passive learning refers to the recall of basic information, and active learning to problem solving. Active learning was required from students during their missions (Appendix 4 and coinciding sections in Appendix 6), when they had to decide how they would go about completing the mission. Frequent and immediate feedback is also needed.

This allows students to learn the facts and procedures correctly. Incorrect interpretation of the information is therefore decrease. In the CBT programme students received immediate feedback when they selected an answer (Appendix 6 pre-test and missions). This was not possible with the control group. Principle three and four refers to different learning activities and grading. These elements were not part of the original study and can only be included as recommendations.

As discussed in Chapter 2 (section 2.1), when designing a course for adults, certain design principles should be included. According to Zemke and Zemke (1984), adults prefer a single concept course that focus on the application of that information to relevant problems. This course only focused on the basic skills needed to read a map and how to apply it. To promote learning there should also be a conceptual overlap with previous knowledge. As all military personnel are trained in map reading during their basic training, this revised course should form an overlap with assumed previous knowledge.

A manual (Appendix 2) was designed for both the experimental and the control group, although the experimental group had the added advantage of having the information presented to them on the computer (Appendix 6). Both trainers received a trainer's manual to prepare for each session. Due to the short time period allocated to the project, some of the information had to be discussed in a self-study manual. Both the groups had to complete the manual before the start of the course. The following section will discuss the principles that were incorporated in the design of both the manuals and the CBT programme.

4.4.1 Training manuals

As mentioned, each student received two manuals. One was a self-study manual (Appendix 6a) that had to be completed before commencing with the course. On the first day of the scheduled classes the second manual (Appendix 6b and d) was received.

It was important to determine the appropriate reading level of the manuals (Landers and Jose, 1986). The manuals included technical information, but it was presented to students of different levels. Instead of overloading the students with information, a concise writing style was used. Sufficient background information was given and attention was drawn to the essence. After writing the manuals it was revised by military experts to ensure that the content is accurate and at an appropriate reading level.

4.4.1.1 Self-study manuals

The self-study manual (Appendix 6a) consisted of four Chapters dealing with an introduction to maps and map reading, units of measure, scales and their application, and a reference section on topographical map symbols.

Each Chapter was divided into four main sections. Section one specified the learning objectives of the particular Chapter and the relevance of the information to be studied (Appendix 6a, e.g. pages 2 and 12). This was followed by a schematic outline or mind map of the Chapter to provide the student with an understanding of how the different sections of information merged into a coherent entity (Appendix 6a, e.g. page 12). Section three consisted of the material to be studied. Examples and diagrams were provided to enhance the learning experience of the student. Special icons were also used to indicate helpful hints and positive/negative aspects of a certain method (Appendix 6a, page 4). Finally, the Chapter was concluded with an exercise (Appendix 6a, sections marked: Exercise). This was followed by the answers to enable the student the evaluate him/herself (Appendix 6a, sections marked: Answers).

A final evaluation and answers were included, covering all four Chapters. The student could use this to determine if he/she was fully prepared for the forthcoming course, or whether there were any areas of uncertainty. This evaluation included multiple choice questions, short answers, and practical

applications of the learning material covered in the manual. As the answers were already included in the manual, this evaluation was not used to collect data.

4.4.1.2 Class manuals

The course was divided into four lessons of no longer than three hours per session. Lesson 1, an introduction (Chapter 1) reviewed the self-study manual (Appendices 6b and d), to ensure that everyone in the group had a clear understanding of the information they had to study on their own. Co-ordinates (Chapter 2) and projections and UTM co-ordinates (Chapter 3) were also covered in this lesson. After lesson 1, students therefore should have had the basic knowledge to orientate themselves on a topographical map. Lesson 2 provided students with further knowledge on the interpretation of a map. Chapter 4 discussed representation of relief, and Chapter 5, contours and contour interpretation. As soldiers should be able to plan a mission they need to be able to calculate slopes and gradients (Chapter 6), and determine intervisibility (Chapter 7). These two Chapters were discussed in lesson 3. Lesson 4 provided students with more practical information. Chapter 8 dealt with the compass, Chapter 9 with determining direction, and Chapter 10 with practical map reading techniques.

Since students were already familiar with the layout of the self-study manual, the same layout was used for the training manuals (Appendices 6b and d). Each Chapter stated the objectives of the specific section, accompanied by an outline or mind-map (Appendices 6b and d, first two pages of each Chapter). The study material was followed by an exercise. Here the training manual differs from the self-study manual, in that no answers were included. The instructor, however still had access to the answers (Appendices 6c and e, sections marked: Exercise). This was an attempt to stimulate class participation and discussion (Knowles, 1986). This was especially necessary for the CBT group, as people could become "lost" because they do not have interaction with each other.

The only difference in the manuals for the two different groups was that the CBT manuals included basic instructions on how to use the computer. These instructions were only necessary for lesson one, as all the subsequent lessons worked on the same principles.

4.4.1.3 Trainer manuals

The manuals for both the CBT and class presenters (Appendix 2c and e) followed the same structure as the student manuals, except for one or two exceptions. Each Chapter started with a Table explaining the order of the work, actions required, and the presentation aids that could be used. The approximate time allocated to the section was also specified. Further instructions were indicated in Italics. A segment called "Setting the Scene" consisted of segments referring to attention, motivation, and context. The objective with this segment was to indicate to students why certain information is relevant and important to them. As in the student manuals, the objectives of the Chapter and the outline or mind-map were provided. The study material followed in the normal manner, and each Chapter was drawn to a close by an exercise. Here the trainer manual differed from the student manual, as answers were provided. The trainer could use this section to stimulate discussion in the class, and to ensure that there are no more uncertainties about the work taught in the session.

4.4.2 CBT Programme

The CBT programme was designed on paper with the help of a template for the storyboard (Appendix 7). The programmers used these storyboards during the development of the computer programme (Alessi & Trollip in McElligott, 1997). Each screen was projected on a separate page that included the screen number, approximate layout, text, sound, graphics, special instructions, and active buttons. The storyboard was also accompanied by the branching between the screens (Appendix 8). This indicated which screen needed to be activated when

the student select forward, back, mind-map, beginning of lesson, or quit (Alessi & Trollip in McElligott, 1997).

A theme was used to try and present the information in an enjoyable and interesting manner, but still within a military context. The student was thus introduced to Operation Night Owl (Appendices 3a and c, and 6) at the start of the programme. Some systems force the user to go through the introductory section over and over again every time they wanted to use the programme. This system was designed in such a manner, that the student could login and go directly to the selected lessons, or to the screen that explains the mission (Appendix 7, screen 2, 3, and 4). Students were required to login with their name and force number (Appendix 7, screen 4). This allowed the requested database to record the lesson already completed. Therefore, on the main menu screen (Appendix 7, screen 5), the student could for instance not study lesson 3 before lesson 2. As soon as lesson 2 was completed, lesson 3 was activated. A student could review any lesson previously studied. All these features can be viewed in the Map-reading programme (Appendix 6).

A quit screen and button was also provided to offer an easy way to exit the programme (Appendix 7, screen 6(a) and (b)). If the quit button was selected, it did not immediately terminate the programme. An intermediate screen appeared to ensure that the student really wanted to quit. If not, the programme reverted back to the last activated screen.

Before the students started with lesson 1, they had to complete a test on the computer involving the information in the self-study manual. This test was indicated by a light blue screen and consisted of five questions (Appendix 7). No typing of answers was required, as students' only needed to select the correct answer. Because students may not have been computer literate, it was necessary to make interaction as simple as possible. As students were not familiar with the keyboard, typing an answer would be too time consuming. After

an answer was selected, an answer-screen appeared explaining the correct answer and the difference between that answer as well as the other that could be selected. A score was calculated (Appendix 7, screen 7g1-4), which determined whether the student (a) could continue with lesson 1, (b) could continue but with the recommendation that the test should be repeated, or finally (c) repeat and pass the test before the student could select lesson 1. If every one could continue, even if they have failed the pre-test, it would result in students not starting with the same background knowledge.

After passing the test the students could select lesson 1. A dark blue screen indicated the different lessons. Landers and Jose (1986) state the importance of ensuring that a student knows where he/she is in a lesson. A mind-map was designed for each lesson (Appendix 7, screen b for each lesson). If certain sections had to be studied before others, they would stay white until they became activated. A soft yellow would indicate sections already completed, and the current active section, by a bright yellow.

With regards to screen design, text, colour and graphics will be discussed. According to McElligott (1997) messages should be typed in an appropriate letter size, using not only capital letters, no justification of paragraphs, and the colours should be contrasted with the background. In the map-reading programme, yellow letters were used on a dark blue background. Yellow is seen as a contrasting colour that catches the eye (Landers and Jose, 1986). Titles were indicted by capital letters and sentence case for the paragraph. The screen was also limited to one concept, as not to make the screen overcrowded or overload the user with information. The computer programme could be viewed (Appendix 6) to see how these principles had been applied.

Graphics should clarify concepts, be relevant, with just enough detail to convey the message and the style of the graphics should be consistent (McElligott,

1997). In most cases cartoon like graphics were used to convey a single idea (Appendix 6, lesson 4, for example).

When using colour, McElligott (1997) found that background colours should be consistent, and if more than five colours are used on a single screen, it may result in visual distraction. If colour is used to indicate a certain action, it should be used consistently. In this programme only three background colours were used. Light blue was used for the test, dark blue for information, and black for the mission (Appendix 6). Buttons on the screen were always in a contrasting soft yellow, and navigational buttons in grey (Appendix 6, lesson 4, for example).

An example of elements included to promote learning is a 3-dimensional globe that could be turned, and folded "flat" for a 2-dimensional view (Appendix 6, lesson 1). To prevent too much information and clutter on a screen, yellow buttons could be selected for more information. Each aspect would then be shown on its own page with the relevant sound, definition, and diagram (Appendix 6, lesson 2, Interpretation of Contour Lines). One of the main problems with teaching map reading is the transition between 2-D and 3-D representations. To establish a link, topographical forms were explained with the aid of a photo of the real feature together with a 2-D interpretation on a real map (Appendix 6, lesson 2, Topographical Forms). With regards to methods for determining slopes and gradients, the student was not overwhelmed with a screen covered with information (Appendix 6, lesson 3). Each method was explained step-by-step, and appeared in a sequential manner, together with a relevant diagram.

To develop the programme, Macromedia Director was used, and Macromedia Coursebuilder was used for programming the questions. It was then displayed as HTML pages. To be able to run the programme, MS Internet Explorer 4 and Macromedia Shockwave is needed. With regards to the computer, a Pentium II

300, sound card, and speakers must be available. As mentioned previously, CyberSim and Quality Training Technology developed the program.

4.4.3 Missions

The information studied was placed in the context of "Operation Night Owl" (Appendices 3 and 6). At the end of each lesson, the students had to complete a specific part of the mission. This provided a way to determine if they could apply their newfound knowledge in a practical exercise.

Landers and Jose (1986) developed a simulation strategy (Figure 4.1) where the student is exposed to a situation, he/she responds, and feedback is given. The situation is then revised and the student is given the opportunity to respond again.

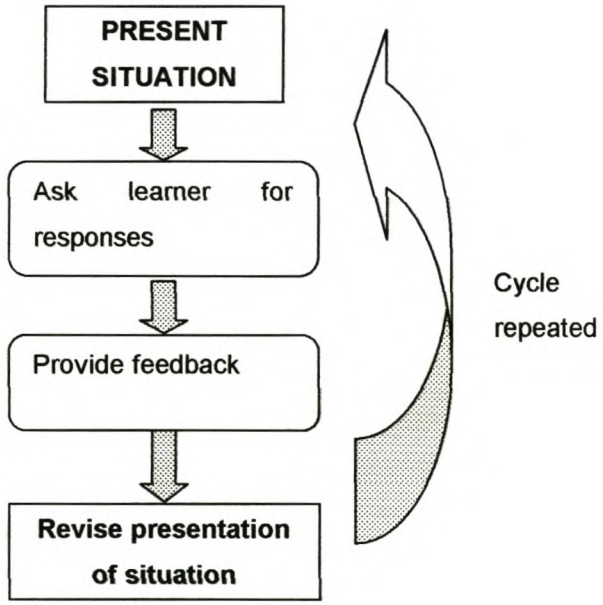

Figure 4.1 Simulation Strategy

(Landers and Jose, 1986)

During the mission the students were asked for a response and received immediate feedback (Landers and Jose, 1986). As the situations presented were not that complex, the situations were not revised. However, for more advanced courses of mission planning, this last step could be included.

The control group had to complete the missions on paper (Appendices 3c and d). The CBT group had the computer as a guide, providing textured maps and possible answers (Appendices 6, Missions). They also had a more realistic feel for the mission as different voices, helicopters, etc. were included. Their final calculations and answers were written on a mission sheet that they handed in to the instructor (Appendix 3a and b).

Multiple-choice questions were used during the mission evaluations. Therefore the student could not come across a situation where the answer was not known, and he/she could not continue. Landers and Jose (1986) stress the fact that users should be able to exit an interaction when they cannot provide a correct response.

CHAPTER 5

Presentation of the course

The map-reading course was presented from Monday to Thursday during the mornings for approximately three hours. Both groups had qualified instructors who had previous experience in map reading. Two aspects that are very important in adult education are self-esteem and ego (Zemke and Zemke, 1984). To study at a later stage in life takes more effort, and adult learners are more sensitive of being treated like children in a class. Both the instructors kept that in mind, and never belittled any of the students during the course. Because some of the students were of higher rank, they had more experience. One of the factors that must be kept in mind when teaching adults is that they have a wealth of information. In both classes, the instructors could have encouraged more participation from senior ranking officers to share their experience in practical map reading. However, caution should be taken not to intimidate officers of a lower rank, once again keeping self-esteem and ego in mind.

Lieb (date unknown) specify four elements that should be addressed in every learning situation, namely, motivation, reinforcement, retention and, transfer. In an attempt to motivate students, it is important to set the tone, appropriate level of concern, and level of difficulty for each lesson. This was achieved by starting each lesson with a section on motivation, context, and objectives (Appendices 2c and e). For retention to occur, students should see the meaning or purpose of that information. During the mission positive reinforcement was used to motivate student and to provide a more positive learning environment. Finally, transfer should occur to the real working environment. This was not included in this study, but is scheduled for a subsequent phase.

5.1 CONTROL GROUP

This group were schooled in their normal training environment at the School of Armour. They had a black- and a white board, a flipchart, and an overhead projector to their disposal. Each student also received a map. Other tools such as a compass, tracing paper, pencil, and eraser were provided when necessary. The instructor even took them outside to teach them how to use a compass.

The instructor presented the class in English, as required by the military, but explained difficult concepts in Afrikaans when needed. The instructor did not mind repeating information, until it was clear to the students. During the missions (Operation Night Owl), the class was divided into groups, who then worked together.

In the beginning the learning motivation of the class seemed low. They also found out that their friends were receiving training on computers. As the majority of the sample group never had any computer training, the control group felt that it was unfair that they had to continue with the normal way of teaching. They were promised that they would subsequently have the opportunity to learn by means of CBT. After the second day they were more motivated and started to enjoy the more practical information in the manuals.

5.2 EXPERIMENTAL GROUP

The experimental group received their classes at Grey College. This was the only venue with enough computers to accommodate 29 students. The computer room was well equipped with enough open desks to provide the space required for working with maps. Zemke and Zemke (1984) state that the learning environment must be physically and psychologically comfortable for adult learners. This was definitely the case.

One of the computers was connected to an overhead projector. No other presentation aids were available. The role of the instructor was only to clarify if there was any uncertainty about the work. In accordance to military regulations, only English was used. Students were also provided with a compass, tracing paper, pencil, and eraser when necessary. They were allowed to practice outside the classroom with the compass.

Students formed natural groups when they answered the questions on their mission sheets. It resulted in students explaining to each other certain aspects of the work. However, caution should be taken not to allow students to simply copy from each other.

Great excitement was experienced among the students because they had the opportunity to learn in a different environment. It took about an hour to familiarise all of them with the use of the mouse. This was accomplished by teaching them to play Solitaire.

They understood that they could repeat the same section of information over and over again, until they had a clear understanding. Some of the students even made a positive comment about it. According to them, one would never ask the same question twice in a conventional class, as your colleagues would think that you are "unintelligent". During CBT they could repeat the information without it having a negative influence on their self-esteem. After completing their daily assignments, some of them even wanted to learn more about the use of a computer.

All computers were equipped with headsets. As soon as students had completed the missions, the headsets were discarded. It seemed to be troublesome to replace the headset each time they had to get up to use the maps. Enough instructions were provided on the computer screen not to make the headsets necessary.

With regards to time allocation, it seemed that more time was needed for the CBT group, than for a class that all completed their assignments at the same time. It is also important to realise the amount of space necessary when working with maps. Because of the tendency to form groups, it is important that a lot of open spaces should be available between learners.

CHAPTER 6

Evaluation and Results

6.1 EVALUATION

Some form of evaluation was necessary to determine the level of knowledge after training, and the extent of retention after one month from the training date. The questions selected for the test focused on the skills defined in the task analysis. Easier questions (e.g. multiple choice) were included in the beginning of a test to put nervous students at ease.

To use the scores from the test for this study, it is important that the tests were valid and reliable (Ebel and Frisbie, 1990). For the test to be valid, the content of the test should represent the knowledge and skills taught in the course. The amount of coverage given to any specific topic in the test, should in addition be systematically related to the importance placed on that work in the teaching situation.

For the test to be reliable, it should provide a consistent measure of a student's performance over a period of time. It is more difficult to establish reliability, because the same test cannot be administered more than once to the same students. To ensure reliability it is important to keep questions clear, avoid ambiguity, and to avoid unclear or unfair scoring systems (Ebel and Frisbie, 1990).

Based on Bloom's Taxonomy (Bloom, 1956), three types of questions were asked. This included knowledge, comprehension, and application. The higher levels of evaluation namely, analysis, synthesis, and evaluation were not included. The information studied and the level of knowledge the students had

acquired, did not provide such an opportunity. All three the evaluations (Appendix 4) focused on both theoretical and practical aspects. Practical questions included the calculation of co-ordinates, gradients, and intervisibility. Students also had to describe certain aspects of wayfinding. Theoretical questions included definitions and identification of symbols.

The format of questions included multiple choice and paragraph format questions. As mentioned before, multiple-choice questions were used to put the nervous student at ease. These questions can be answered quickly, and the score can be recorded easily and reliably. The other questions consisted of paragraph format type questions that sometimes were accompanied by an illustration. These questions provided the opportunity to see how well students can express their thoughts.

Three tests (Appendix 4) were used to evaluate the students and to gather data regarding their performance. The pre-test (Appendices 4a and b) was written two weeks before the commencement of the course. Only after everyone had completed the test, did they receive the self-study manual. After the four-day course, a post-test (Appendices 4c and d) was written, covering all the work discussed in both the self-study and the class manuals. One month later, retention was measured by writing a similar test (Appendices 4e and f). The students were not informed about these tests. This was an attempt to measure their natural learning ability and retention, without allowing time for study or preparation.

6.2 RESULTS

6.2.1 Pre-test analysis

Analysis of variance (ANOVA) was performed to determine whether the two groups were statistically similar in their initial degree of map reading knowledge. The P-value of 0,898 (Table 6.1), as compared to an critical exceedence probability value of 0,05, indicates that no significant (p>,05) difference in the initial degree of map reading knowledge exists. The differences between the means are therefore not great enough to allow for the interpretation that the two populations are dissimilar. The implicit assumption made by the randomised group design, that random assignment should control the threat of differential selection, therefore seems to be justified.

Table 6.1 Single factor ANOVA pre-test results

SUMMARY

Groups	*Count**	*Sum*	*Average*	*Variance*
CBT	28	595	21.25	124.8843
Class	29	626.25	21.59483	81.57328

*Not all the subjects wrote the pre-test, as was required.

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.69389	1	1.69389	0.016472	0.898346	7.119411
Within Groups	5655.927	55	102.835			
Total	5657.621	56				

6.2.2 Knowledge acquisition

Table 6.2 (class) and Table 6.3 (CBT), display the average test percentage increases from the pre-test to the first post-test (knowledge acquisition). For the

class group the increase was 15,2 % and for the CBT group 19 %. Although the increases would indicate that an increase in 'natural' knowledge (i.e. knowledge gained by only attending class and without dedicated study) had occurred after the training phase, a paired samples t-test was conducted for each group to evaluate the statistical significance of knowledge acquisition (Table 6.2 and Table 6.3). Subjects with missing values on either the pre-test or the post-test were excluded from the paired samples' t-test procedure. The null hypothesis is that there is no significant difference between the means of the pre-test and post-tests for each group. From Table 6.2 it is evident that the exceedence probability associated with the observed sample difference, is greater than 0.05 and therefore the null hypothesis is not rejected for the class group. The increase in 'natural' knowledge is therefore not statistically significant ($p>0,05$). However, from Table 6.3 it can be seen that the probability of observing the sample results under the null hypothesis, is less 0.05 and therefore the increase in 'natural' knowledge for the CBT group is statistically significant ($p<0,05$).

Table 6.2 Paired sample t-test on pre-test and post-test performance of class group

Paired sample t-test for means

	Class pre-test	*Class post-test*
Mean	22.33695652	24.8773913
Variance	94.92959486	79.99506561
Observations	23	23
Pearson Correlation	0.360928623	
Hypothesized Mean Difference	0	
df	22	
t Stat	-1.151130179	
P(T<=t) one-tail	0.131018261	
t Critical one-tail	1.717144187	
P(T<=t) two-tail	0.262036522	
t Critical two-tail	2.073875294	

Table 6.3 Paired sample t-test on pre-test and post-test performance of CBT group

Paired sample t-test for means

	CBT pre-test	*CBT post-test*
Mean	21.68478261	25.41086957
Variance	143.9785079	180.0578083
Observations	23	23
Pearson Correlation	0.86026278	
Hypothesized Mean Difference	0	
df	22	
t Stat	-2.606194347	
P(T<=t) one-tail	0.008061348	
t Critical one-tail	1.717144187	
P(T<=t) two-tail	0.016122697	
t Critical two-tail	2.073875294	

6.2.3 Evaluating H_{01}

Hypothesis 1 states that CBT enhances the acquisition of 'natural' knowledge when teaching users how to read a 2D map. A single factor ANOVA test was performed to evaluate this hypothesis by testing H_{01}. The P-value in Table 6.4 is substantially larger that the critical exceedence probability of 0,05 and therefore the relevant null-hypothesis (H_{01}) is not rejected. The difference between the class and CBT means for post-test 1 (knowledge acquisition) is not great enough to statistically preclude that the difference in mean post-test performance may be due to sampling error. The study therefore fails to corroborate the hypothesis that CBT enhances the acquisition of map reading knowledge, over that achieved by conventional classroom teaching. In an effort to increase the statistical power of the analysis, the variance in knowledge acquisition that could be explained in terms of variance in the pre-test measure, was first partialled out through analysis of covariance before examining the effect of training programme on the

first post-test scores. This, however, failed to minimize the error variance to such an extent that H_{01} could be rejected.

Table 6.4 One-way ANOVA for post-test 1 results between CBT and Class groups

SUMMARY

Groups	*Count**	*Sum*	*Average*	*Variance*
CBT	25	632.23	25.2892	165.4627
Class	23	572.18	24.87739	79.99507

*Not all the subjects wrote the post-test 1, as was required.

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.031504	1	2.031504	0.016306	0.89894725	7.220024
Within Groups	5730.997	46	124.5869			
Total	5733.029	47				

6.2.4 Knowledge retention

From the paired sample t-test results in Table 6.5 and Table 6.6, it may be concluded that no significant amount of knowledge was lost after a one-month period for both the class and CBT groups. The small amount of 'natural' knowledge incurred after the pre-test phase has been retained.

Table 6.5 Paired sample t-test on Post-test 1 (acquisition) and Post-test 2 (retention) performance for class group

Paired samples t-test for means

	Class post-test 2	*Class post-test 1*
Mean	24.665	27.935
Variance	312.94315	69.67538077
Observations	14	14
Pearson Correlation	-0.096438849	
Hypothesized Mean Difference	0	
df	13	
t Stat	-0.603445855	
P(T<=t) one-tail	0.278297548	
t Critical one-tail	1.770931704	
P(T<=t) two-tail	0.556595096	
t Critical two-tail	2.16036824	

Table 6.6 Paired sample t-test on Post-test 1 (acquisition) and Post-test 2 (retention) performance for CBT group

Paired samples t-test for means

	CBT post-test 2	*CBT post-test 1*
Mean	23.99714286	28.33357143
Variance	275.539222	238.1247016
Observations	14	14
Pearson Correlation	-0.31248189	
Hypothesized Mean Difference	0	
df	13	
t Stat	-0.625096969	
P(T<=t) one-tail	0.271362342	
t Critical one-tail	1.770931704	
P(T<=t) two-tail	0.542724685	
t Critical two-tail	2.16036824	

6.2.5 Evaluating H_{02}

Comparing the means for post-test 2 (retention) results for the class and CBT groups clearly indicate that the performance level attained in the month prior to the retention test, had not been differentially lost by the two group to any significant degree. An ANOVA test between the two groups (Table 6.7), indicates that H_{02} cannot be rejected. In this case CBT training does not contribute to retention in any statistically significant degree. In an effort to increase the statistical power of the analysis, the variance in knowledge retention that could be explained in terms of variance in the pre-test measure was first partialled out through analysis of covariance before examining the effect of training programme on the second post-test scores. Again the loss of additional degrees of freedom, combined with the relatively small reduction in error variance, meant that the ANCOVA could not overturn the verdict returned by the ANOVA.

Table 6.7 One-way ANOVA for H_{02}

SUMMARY

Groups	*Count**	*Sum*	*Average*	*Variance*
CBT	14	335.96	23.99714	275.5392
Class	14	345.31	24.665	312.9432

*Not all the subjects wrote post-test 2, as was required.

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.122232	1	3.122232	0.010611	0.918745	4.2252
Within Groups	7650.271	26	294.2412			
Total	7653.393	27				

6.2.6 Evaluating H_{03} and H_{04}

Due to logistic reasons the data sets necessary to adequately evaluate H_{03} and H_{04} were not gathered. However, students did complete a subjective evaluation (Appendix 5) to indicate how they had experienced the course. Both groups completed this questionnaire. Some of this data were subsequently used in an attempt to still, despite the logistic setback, explain variance in the two sets of post-test measures, in terms of variables that characterize the manner in which students approached the programme or their subjective experience of the programme. The following seven variables were taken into account:

- enjoyed the idea of the mission and applying knowledge to a practical problem (X_1);
- completed self-study manual before course (X_2);
- frustration experienced with duration of lessons (X_3);
- enjoyed the format of the manual (X_4);
- satisfied with the course (X_5);
- understood new information (X_6);
- errors in the system was frustrating (X_7).

Information on X_7 was obtained from the CBT group only. Although the possibility was initially considered to treat these measures as approximate indicators of the original latent variables of interest (refer to Figure 2.4, page 30), this option was not regarded as sufficiently convincing and consequently not pursued in the subsequent analyses.

The initial third research hypothesis was therefore reformulated as follows:

H_3: The acquisition and retention of knowledge for map reading are dependent on the extent to which learners enjoyed the idea of the mission and applying knowledge to a practical problem, the extent to which they complete the self-study manual before the course, the extent to which they find the course frustrating, the extent to which they enjoy the training manual, the extent to which they find the course satisfying and the extent to which they understand the presentation of the learning material.

An ex post facto correlational design was used to test the following variations on the statistical hypotheses formulated earlier:

H_{03ji}: $\rho(Y_j,X_i)$; j=1, 2 and i=1, 2, …., 7

$H0_{41j}$: $\beta[X_1]=0|\beta[X_2]\neq0;\beta[X_3]\neq0;\beta[X_4]\neq0;\beta[X_5]\neq0;\beta[X_6]\neq0$

$H0_{42j}$: $\beta[X_2]=0|\beta[X_1]\neq0;\beta[X_3]\neq0;\beta[X_4]\neq0;\beta[X_5]\neq0;\beta[X_6]\neq0$

$H0_{43j}$: $\beta[X_3]=0|\beta[X_1]\neq0;\beta[X_2]\neq0;\beta[X_4]\neq0;\beta[X_5]\neq0;\beta[X_6]\neq0$

$H0_{44j}$: $\beta[X_4]=0|\beta[X_1]\neq0;\beta[X_2]\neq0;\beta[X_3]\neq0;\beta[X_5]\neq0;\beta[X_6]\neq0$

$H0_{45j}$: $\beta[X_5]=0|\beta[X_1]\neq0;\beta[X_2]\neq0;\beta[X_3]\neq0;\beta[X_4]\neq0;\beta[X_6]\neq0$

$H0_{46j}$: $\beta[X_6]=0|\beta[X_1]\neq0;\beta[X_2]\neq0;\beta[X_3]\neq0;\beta[X_4]\neq0;\beta[X_5]\neq0$

} j=1,2

A series of simple, zero-order correlation analysis were used to test H_{03ji}. The matrix of zero-order correlation coefficients would reflect the extent to which each of the seven individual predictor variables explain variance in the two post-test measures. Standard multiple linear regression was used to examine hypothesis

H_{04ij}. X_7 was not entered into the regression analysis, since its inclusion would seriously reduce the effective sample size. Multiple linear regression was performed to model the acquisition gain and the retention loss (dependent variable), in terms of the remaining six independent variables. H_{04ij} tests whether each of the predictor variables significantly explain unique variance in the dependent variable [acquisition or retention], not explained by any other effect included in the model.

The correlations between the two post-test measures and the six subjective programme evaluation ratings are depicted in Table 6.8.

Table 6.8 Correlation matrix

		Acquisition of knowledge	Retention of knowledge	Satisfied with course	Understand new material	Frustration with duration of lesson	Enjoyed format of manual	Enjoyed completing missions	Completed self-study manual	Frustrated with errors in CBT
Acquisition of knowledge	Pearson Correlation	1.000	.308	.048	-.225	.154	-.251	-.026	-.052	.417*
	Sig. (2-tailed)	.	.126	.753	.128	.303	.093	.866	.734	.043
	N	48	26	46	47	47	46	46	46	24
Retention of knowledge	Pearson Correlation	.308	1.000	.174	-.217	-.012	-.244	.011	.116	.511
	Sig. (2-tailed)	.126	.	.417	.297	.954	.240	.959	.581	.075
	N	26	28	24	25	25	25	25	25	13
Satisfied with course	Pearson Correlation	.048	.174	1.000	.217	-.620**	.376*	.625**	-.095	-.028
	Sig. (2-tailed)	.753	.417	.	.142	.000	.010	.000	.533	.894
	N	46	24	47	47	47	46	46	45	25
Understand new material	Pearson Correlation	-.225	-.217	.217	1.000	-.340*	.173	.151	.197	-.154
	Sig. (2-tailed)	.128	.297	.142	.	.018	.245	.312	.188	.462
	N	47	25	47	48	48	47	47	46	25
Frustration with duration of lesson	Pearson Correlation	.154	-.012	-.620**	-.340*	1.000	-.370*	-.431**	-.031	.244
	Sig. (2-tailed)	.303	.954	.000	.018	.	.010	.003	.838	.239
	N	47	25	47	48	48	47	47	46	25
Enjoyed format of manual	Pearson Correlation	-.251	-.244	.376*	.173	-.370*	1.000	.485**	.275	-.450*
	Sig. (2-tailed)	.093	.240	.010	.245	.010	.	.001	.065	.027
	N	46	25	46	47	47	47	47	46	24
Enjoyed completing missions	Pearson Correlation	-.026	.011	.625**	.151	-.431**	.485**	1.000	-.064	-.048
	Sig. (2-tailed)	.866	.959	.000	.312	.003	.001	.	.673	.823
	N	46	25	46	47	47	47	47	46	24
Completed self-study manual	Pearson Correlation	-.052	.116	-.095	.197	-.031	.275	-.064	1.000	-.380
	Sig. (2-tailed)	.734	.581	.533	.188	.838	.065	.673	.	.073
	N	46	25	45	46	46	46	46	46	23
Frustrated with errors in CBT	Pearson Correlation	.417*	.511	-.028	-.154	.244	-.450*	-.048	-.380	1.000
	Sig. (2-tailed)	.043	.075	.894	.462	.239	.027	.823	.073	.
	N	24	13	25	25	25	24	24	23	25

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

**. Correlation is significant at the 0.01 level (2-tailed).

The results presented in Table 6.8 indicate that H_{03ij} cannot be rejected for i=1, 2, 3, 4, 5, 6, given j=1 [i.e. first post-test or acquisition measure] and for i=1, 2, 3, 4, 5, 6, 7 given j=2 [i.e. second post-test or retention measure]. Therefore Table 6.8 indicates that only one of the subjective evaluation measures significantly ($p<0,05$) explains variance in the first post-test measure. A moderate positive correlation ($r=0,417$; $p<0,05$) exists between the acquisition of knowledge and frustration experienced due to system errors in the CBT programme. Therefore

the lower the frustration experienced during training, the higher the acquisition of knowledge. The majority of the CBT students indicated that they did not experience frustration due to system errors. Table 6.8 indicates that none of the subjective evaluation measures, significantly ($p>0,05$) explain variance in the second post-test measure. Table 6.8 does, however, indicate moderate and significant ($p<0,05$) correlations between X_1, X_3, X_4 and X_5. These four variables reflect the satisfaction of learners with various facets of the course. Especially noteworthy is the moderately strong negative and statistically significant correlation ($r=-0,620$; $p<0.05$) between the extent to which learners were frustrated with the duration of the lessons (X_3) and the extent to which they were satisfied with the course (X_5). The frustration with the duration of lessons seems to arise from the perception that lessons were too short. The other important factor that seems to have influenced the overall satisfaction with the course seems to be the extent to which learners enjoyed completing the practical missions ($r=0,625$; $p<0,05$). The moderate negative and statistically significant correlation ($r=-0,340$; $p<0,05$) between the extent to which learners found the duration of lessons frustrating (X_3) and the extent to which they understood the newly presented learning material (X_6) also seems to be worth mentioning. This trend, combined with the relatively low initial levels of map reading competency, might provide a partial explanation for the small increases in map reading proficiency achieved by both courses.

The results depicted in Table 6.8 provide very little justification to proceed with the envisaged regression analysis. Although H_{04ij} will almost certainly not be rejected for all i and j, the possibility of significant partial effects due to the nature of the inter-predictor correlations, nonetheless still had to be examined. The regression of the first post-test measure on the six subjective evaluation ratings is shown in Table 6.9.

Table 6.9 The regression of the first post-test measure on the six subjective evaluation ratings.

Model Summary

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.421a	0.177	0.047	11.1045

a Predictors: (Constant), Completed self-study manual, Frustration with duration of lesson, Understand new materia Enjoyed completing missions, Enjoyed format of manual, Satisfied with course

ANOVA b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1008.838	6	168.14	1.364	0.254a
	Residual	4685.762	38	123.31		
	Total	5694.601	44			

a Predictors: (Constant), Completed self-study manual, Frustration with duration of lesson, Understand new material, Enjoyed completing missions, Enjoyed format of manual, Satisfied with course

b Dependent Variable: Acquisition of knowledge

Coefficients a

		Unstandardized Coefficients		*Standardized Coefficients*	*t*	*Sig.*
Model		B	Std. Error	Beta		
1	(Constant)	24.068	12.545		1.918	0.063
	Satisfied with course	3.184	2.473	0.28	1.288	0.206
	Understand new material	-3.946	2.464	-0.262	-1.602	0.118
	Frustration with duration of lesson	1.176	1.825	0.13	0.644	0.523
	Enjoyed format of manual	-4.065	2.336	-0.317	-1.74	0.09
	Enjoyed completing missions	0.705	2.61	0.055	0.27	0.788
	Completed self-study manual	1.048	1.445	0.117	0.725	0.473

a Dependent Variable: Acquisition of knowledge

Table 6.9 indicates, as expected, that none of the predictors significantly (p>0,05) explain unique variance in the knowledge acquisition post-test measure, not explained by the other predictors included in the regression model. H_{04ij} can therefore not be rejected for i=1, 2, 3, 4, 5, 6 and j=1. Further interpretation of the regression statistics thus would be pointless.

The regression of the second post-test measure on the six subjective evaluation ratings is shown in Table 6.10.

Table 6.10 The regression of the second post-test measure on the six subjective evaluation ratings.

Model Summary

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.537	0.289	0.038	15.9662

a Predictors: (Constant), Completed self-study manual, Understand new material, Enjoyed completing missions Enjoyed format of manual, Satisfied with course, Frustration with duration of lesson

ANOVA

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
1	Regression	1759.755	6	293.292	1.151	0.377a
	Residual	4333.643	17	254.92		
	Total	6093.397	23			

a Predictors: (Constant), Completed self-study manual, Understand new material, Enjoyed completing missions, Enjoyed format of manual, Satisfied with course, Frustration with duration of lesson

b Dependent Variable: Retention of knowledge

Coefficients

Model		*Unstandardized Coefficients* B	Std. Error	*Standardized Coefficients* Beta	*t*	*Sig.*
1	(Constant)	9.143	41.833		0.219	0.83
	Satisfied with course	6.76	5.045	0.436	1.34	0.198
	Understand new material	-6.246	5.101	-0.275	-1.224	0.237
	Frustration with duration of lesson	2.513	6.076	0.163	0.414	0.684
	Enjoyed format of manual	-7.009	4.497	-0.408	-1.558	0.138
	Enjoyed completing missions	3.168	7.443	0.169	0.425	0.676
	Completed self-study manual	5.212	3.195	0.365	1.631	0.121

a Dependent Variable: Retention of knowledge

Table 6.10 indicates, as expected, that none of the predictors significantly ($p>0,05$) explain unique variance in the knowledge retention post-test measure, not explained by the other predictors included in the regression model. H_{04ij} can therefore not be rejected for i=1, 2, 3, 4, 5, 6 and j=2. Further interpretation of the regression statistics thus would be pointless.

6.2.7 Correlations between biographical data and test results

Correlations were subsequently calculated between the two sets of post-test measures and a number of biographical variables for the combined sample. The resultant correlation matrix is depicted in Table 6.11.

Table 6.11 Correlations between knowledge acquisition, knowledge retention, and biographical variables.

		Acquisition	Retention	Rank	Education	Previous map training
Acquisition	Pearson Correlation	1.000	.308	.454**	.261	.068
	Sig. (2-tailed)	.	.126	.001	.080	.650
	N	48	26	47	46	47
Retention	Pearson Correlation	.308	1.000	.430*	-.467*	-.153
	Sig. (2-tailed)	.126	.	.025	.014	.448
	N	26	28	27	27	27
Rank	Pearson Correlation	.454**	.430*	1.000	.003	-.138
	Sig. (2-tailed)	.001	.025	.	.981	.302
	N	47	27	58	57	58
Education	Pearson Correlation	.261	-.467*	.003	1.000	.267*
	Sig. (2-tailed)	.080	.014	.981	.	.045
	N	46	27	57	57	57
Previous map training	Pearson Correlation	.068	-.153	-.138	.267*	1.000
	Sig. (2-tailed)	.650	.448	.302	.045	.
	N	47	27	58	57	58

**. Correlation is significant at the 0.01 level (2-tailed).

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

Although no substantive or statistical hypotheses were formulated in this regard, interesting and useful results nonetheless emerged.

Table 6.11 indicates a modest positive and statistically significant correlation between acquisition of knowledge and rank (r=0,454; p<0,01). When analysing the same relationship within the two treatments, the same trend emerges. For both the Class (r=0,527; p<0,05) and the CBT (r=0,509 p<0,05) groups, a modest positive and significant correlation is found between the acquisition of knowledge and rank. Soldiers of higher rank thus tend to achieve higher knowledge retention scores than those of lower ranks. This could possibly be attributed to the fact that a soldier of higher rank has, or ought to have, more experience and knowledge than a private. Table 6.11 furthermore indicates a modest positive and significant correlation between retention of knowledge and rank (r=0,430; p>0,05). When analysing the same relationship within the two treatments, a moderately strong and significant correlation between rank and knowledge retention is observed for the class group (r=0,625; p<0,05), but only a weak and insignificant correlation is found for the CBT group (r=0,189; p>0,05).

This seems to imply that previous experience does not necessarily result in better retention of new information studied.

Table 6.11 indicates a weak positive and insignificant correlation of (r=0,261; p>0,05) between educational level and knowledge acquisition. Analysis within groups indicates a weak (r=0,385) and insignificant (p>0,05) correlation between educational level and knowledge acquisition for the class group, and an even weaker (r=0,176) and insignificant correlation (p>0,05) for the CBT group. Table 6.11 somewhat surprisingly indicates a negative and significant correlation (r=-0,467; p>0,05) between educational level and knowledge retention. Both groups demonstrate a negative correlation (r=-0,565 and r=-0,370) after one month, although only the class correlation is statistically significant (p<0,05).

It was assumed that previous experience in map reading should influence an individual's post-test scores. Contrary to expectations, Table 6.13 indicates a low and insignificant correlation between previous experience and knowledge acquisition (r=0,068; p>0,05). An extremely low correlation (r=0,002; p>0,05) between knowledge gained and previous map reading experience is found after the first post-test for the class group. Likewise, a low positive correlation (r=0,120; p>0,05) is found after the first post-test for the CBT group. Previous experience also is unrelated to retention in the combined group (r=-0,153; p>0,05) and within the separate treatments (r=-0,278; p>0,05 and r=-0,019; p>0,05).

6.2.8. Subjective results

With regards to the computer generated map-reading course, the CBT students were satisfied overall (88,5 %). Only two students found it frustrating to work on a PC, and five students found the errors frustrating. Errors included a Windows based illegal operation by one of the computers, and the login function was too

case sensitive. Overall (88 %) the students found operating the programme easy.

The majority of the students (96 %) were of the opinion that the computer programme improved their understanding of map reading, especially the diagrams (91,7 %), highlighting of important information (91,7 %), and the photos of topographical forms (92 %). As expected 72 % of the students thought that the mind map should be included into the computer programme and not be provided on paper.

With regards to the class, only two students were not satisfied and five indicated that the class was frustrating to attend. 90 % of the students felt that the presenter contributed to their understanding of map reading. The contribution of diagrams (86,4 %) and highlighting of information (86,4 %) were rated highly, although somewhat less than by the CBT groups' 91,7 % for both questions.

In both courses a mission was used throughout the course to let students apply their knowledge to a particular practical situation. 96 % of the CBT and 95,5 % of the class students enjoyed the idea of the mission. 92 % of the CBT students felt that the mission promotes understanding, whereas 81,8 % of the class group had the same opinion.

Both groups have also received manuals to accompany the course. The manual was not in standard military format. User-friendly diagrams and icons accompanied all information. The CBT group was more positively inclined (92 %) towards the manuals than the class (72,7 %). 84 % of the CBT group and 80,4 % of the class also felt that the manual contributed towards their understanding of map reading. 75 % of the CBT group stated that they did complete the self-study exercises before commencement of the course, in contrast to the class where only 45 % of the students completed the manual beforehand.

The students were required to indicate their level of understanding of the information studied during the map-reading course. Only three people in the CBT class admitted that they did not understand the information completely. 100 % of the control group said they understood the work completely. In both cases this confidence was not reflected in the grades scored in the tests.

Both groups felt that they were highly motivated (above 90 %). This could be true of the CBT group where all 29 students attended all the sessions. However, a number of students from the class group did not turn up and they were not punctual.

In conclusion both hypothesis H_{01} and H_{02} could not be rejected. Further investigation is necessary for the original hypothesis H_{03} and H_{04}.

CHAPTER 7

Conclusions and Recommendations

7.1 CONCLUSIONS

Three reasons can be offered for the apparent low scores achieved by the sample group. Firstly, the tests that were written were not studied for. If the students would have been informed about the evaluation, they would have had the opportunity to study. However, the objective of this study was not to measure the students study abilities, but the natural retention that will occur after a certain training method. In a study done by Gardiner (1998), he found rare high values of 50 percent recall, but values of 20 percent or less were common. This may place the results of this study into perspective.

The other factor that may have played a role is motivation. The fact that adults seek to better themselves when a specific life-changing event is a certainty. They search for information and skills that they would have immediate use for. Most of all, adults' sense of self-esteem plays a role in deciding if they want to study further (Zemke and Zemke, 1984). In this study, this kind of motivation probably did not play a role. The sample group attended this study because they were instructed to do so, and did not have any other courses to attend. The map-reading course also did not lead to promotion, as is often the case with other training courses. Most students may not have had a direct interest in the course and only attended because they were required to do so. Due to low motivation, which can act as a barrier, students did not learn as much as they would have, if they had been truly interested in the subject matter.

Finally, according to Zemke and Zemke (1984) integrating new skills and knowledge takes time and a focused effort from the student. Some students might not have focused on the information and there was very little time to assimilate all this new information.

In Maslow's hierarchy of needs, Maslow (1954) refers to humans' need for esteem. Humans have a need for self-respect and respect from others. This was evident in remarks made by students in the CBT group. They remarked that this was the first time that they felt they were receiving real and individual attention. During the CBT programme, they never felt embarrassed because they did not need to ask the same question over and over again. The computer was always available to repeat the same set of information.

7.2 RECOMMENDATIONS

7.2.1 Sample size

The size of the sample group is very important as it influences the statistical results. Even though a sample group of 60 was seen as adequate, it proved to be problematic. This was predominantly due to the fact that the sample group could not be controlled. Other courses, appointments, and even leave received precedence over the test dates. To accommodate these problems, a larger sample group should be selected.

7.2.2 When to present the course

It is recommended that this course should not be presented as a stand-alone CBT programme, but as part of a complete training intervention.

Billington (2000) identifies seven characteristics that needs to be included in adult learning programmes:

- Students must feel save and supported.
- The environment must encourage experimentation and creativity.
- Adults must be treated with respect and as peers.
- Adults must take responsibility for their own learning.
- The course must provide an intellectual challenge.
- Active involvement in learning is necessary.
- Students must receive regular feedback.

When presenting map reading training these seven principles should be included. The current map reading course may not have provided senior officers with an intellectual challenge and the students definitely did not take responsibility for their own learning.

Because adults attend courses that have direct relevance in their lives, the map-reading course should be presented when soldiers are ready for operational deployment. They would be more motivated to learn something that has direct relevance for the future.

7.2.3 Changes to the programme

One change that can be made to the CBT programme is to include numbers on the screen display. Landers and Jose (1986) states that it gives students more direction when they know that there are, for example, 5 of 16 screens left to complete.

It is also recommended that the screens are made more interactive. More activities need to be added, e.g. answering questions in different formats, or video clips. Because this programme can be used for students at different levels

of education, more questions and examples should be added. Students should have the option of choosing how many examples he or she prefers to be given.

By programming the course as designed in the storyboard, the navigation through the electronic mind map will also give students a better sense of control over the programme.

With regards to the test, evaluation could be easier if all questions for the pre-test, missions, and post-test could be completed on and recorded by the computer. Most importantly, if more questions and interactivity is included in the programme, the students could receive more feedback.

7.2.4 Working with other groups

The Chief Directorate of Surveys and Mapping (CDSM) have taken it upon them self to promote map literacy in South Africa. They pride themselves on making maps more available, providing teaching aids and Map Trix, as well as Adult Education Workshops. At this stage they do not have CBT packages to add to their lists. It may be a viable option to perform collaborative research with this group, as CBT may yet prove to lead to better retention of information learned from map reading courses.

7.2.5 Combining techniques

It may be viable to combine classroom teaching with computer training. The positive aspects of lectures are, that it can present factual material in a direct and logical manner, the lecturer and students have experience which inspires, and it may stimulates thinking towards open discussion. This method is also useful for large groups. However, an expert does not guarantee good teaching abilities. The size of the class can also cause students to be passive and communication to be only one-sided. It is also difficult to determine whether learning has occurred.

When combined with small groups, there are definite advantages for effective teaching. A small group provides the opportunity for everyone to participate. Due to the fact that it is a smaller group, individuals might feel more comfortable with being vocal. Small groups require more preparation from the facilitator, and he/she must be careful not to let the group get side tracked (University of Hawaii, undated).

Gardiner (1998) states that discussion promotes retention and the application of new knowledge to real situations, even though between 70-90 % of facilitators do not apply this technique. During the completion of the missions', students tended to form natural groups. As it may result in better retention of new information, it is therefore recommended that the map-reading course be combined with more discussion groups. Fink (1999) also recommends that a variety of lectures, discussions, and small groups should be included in a course to promote optimal learning.

Finally, a second dimension was added to the map reading programme. The maps used during the missions were converted into a 3D virtual terrain. Both groups had a chance to execute the missions after the course in the 3D simulated environment. Based on the literature study, it was believed that CBT, or in a later stage even Virtual Reality, will contribute to the teaching of map reading. After spending some time in the virtual world, both groups completed a subjective evaluation. Even though the terrain was limited, the students enjoyed the freedom that the terrain provided them to manoeuvre through. In short, the subjective evaluations indicated that as much detail as possible is necessary to make the virtual world as realistic as possible.

In conclusion, the results do not suggest that CBT is the way to promote the teaching of map reading. However, based on the small sample group, these results are definitely not conclusive. It is therefore recommended that the study

be repeated, with different sample groups of a larger size, and that the recommended changes are made to the programme. Numerous literature sources (Chappel, date unknown, McElligott, 1997; Gery, 1996; Janicak, 1999; Landers and Jose, 1986) indicate that CBT can contribute significantly to the learning experience, making it plausible that CBT could indeed, upon further analysis, prove to contribute to teaching map reading.

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