COMPUTER ANXIETY AND MENTAL MODELS OF FIRST TIME ADULT COMPUTER USERS

Pamela Bain

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ABSTRACT

Computers are here to stay (Marcoulides, 1995), however there are still many people who are learning about computers for the first time. Since there is a distinct lack of understanding on whether computer attitudes will change subsequent to controlled exposure to computers, as well as little sound research on mental model change with respect to interaction with computers, an ex post facto, matched-pairs with control group field research design it was deemed necessary to ascertain changes in attitudes and mental models as a result of a 'basic skills in computing' course. Additionally various variables that would influence these variables were also considered, including prior knowledge/usage of computers, prior exposure to computer-like devices, and demographic variables.

The research sample consisted of sixty two trainees prior to the course, thirty three subsequent to the course measures and eleven control group subjects tested over a similar time span. The Loyd and Gressard (1984) scale of computer attitudes was used, incorporating measures of computer anxiety, computer confidence, computer liking and overall attitudes towards computers. The subjects were also required to draw their mental model of what was 'under the lid of the computer box' and to fill out a demographics questionnaire.

The results revealed that home language, occupation, prior knowledge/usage of computers and to some extent age influenced computer attitudes and furthermore, these no longer influenced attitudes subsequent to the course. A change in overall computer attitudes as well as confidence was also found. However, the control group did not differ significantly from that of the experimental group in terms of attitudes in order to confirm this effect. Demographic variables did not effect mental model conceptualisations, however they did vary as a result of the computer course and these results

were confirmed in that the control group remained the same. Additionally prior exposure to computers in terms of having either seen, used or owned computers related to mental models although knowledge/usage of computers did not.

The implications that these results have in terms of the influence that training courses have on attitudes and mental models are presented. While every effort was made to ensure that a sound research design was used, several limitations of the research were discussed. Suggestions for improvement and areas for future studies are, as a result, delineated.

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master in Arts at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

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INTRODUCTION

With the evolving nature of workplaces today in terms of high technology and more specifically computers, personnel are faced with the notion of 'adapt or die' in terms of facing these ever-changing technologies (Rowe and Cook, 1995).

Mounting interest in cognitive foundations of learning and interaction with technology has led to growing interest in representing and analysing the mental models of individuals (Carley and Palmquist, 1992; Booth, 1990). Psychologists have attempted to understand mental models, using a variety of methodologies, however, owing to the fact that they are unobservable and the study of these mental representations is relatively new, the research aims to contribute to understanding by studying the impact of training on the mental models of first time adult computer users. Further discussion of the pertinent literature can be found in Chapter 2.

The prevalence of computer anxiety and negative attitudes towards computers and the reluctance of managers to use computerised systems have been extensively documented in the literature (Igbaria and Parasuraman, 1989). However, very few studies have utilised a sound research design to analyse the impact of a training course on computer anxiety and attitudes in general. Chapter 3 highlights the relevant literature.

Bearing in mind the above discussions and the fact that more and more people are interacting with computers in their daily lives the literature review now focuses on the aspects of prior knowledge and usage of computers influencing learning, attitudes and cognitive conceptualisations. These issues are further addressed in Chapter 4.

Based on the literature review, eight hypotheses were drafted and these are presented, along with a summary of the first part of this dissertation, in Chapter 5.

This study assessed the impact of a 'basic skills in computing' course on the mental models and computer anxiety of first time adult computer users using a measure of attitudes and utilising the method of drawing conceptualisations of what a computer looks like 'under the lid of the computer box'. Further elaboration of the methodology can be found in Chapter 6.

The results (Chapter 7) are presented in order of the analysis procedures that were conducted, however, the discussion (Chapter 8) follows the hypotheses as they were outlined in chapter 5.

Finally, Chapter 9 delineates the implications, limitations, areas for future research and conclusions of this study.

PART ONE: LITERATURE REVIEW

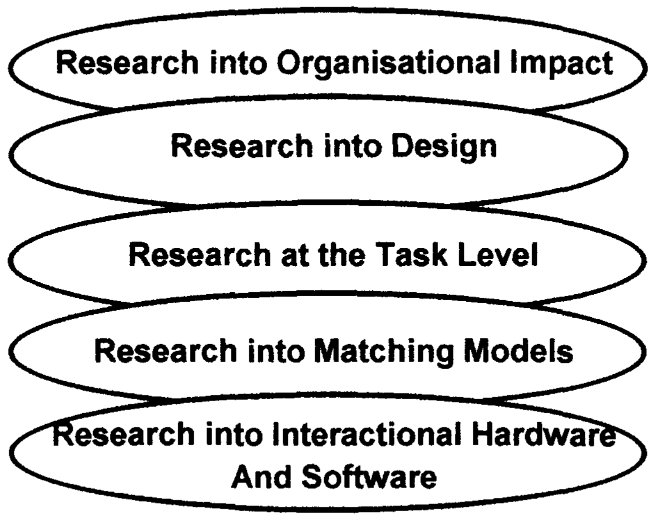
CHAPTER 1: INTRODUCTION

Computers have become an ever-increasing factor in our everyday lives (Zakrajek, Waters, Popovich, Craft and Hampton, 1990). Individuals are purchasing computers for home use, schools are incorporating computers into curricula and businesses are utilising computers for a wide variety of aspects in their organisations (ibid.). However, in previous decades, the majority of computer users were themselves programmers and designers. Consequently, a person using a computer system was likely to be familiar with, and to follow, the same conventions and culture as the individual who designed it (Booth, 1990). But in view of the fact that computers have become so pervasive in businesses and homes, there has been a substantial growth of users who are not computer experts (ibid.). Shackel (1985, p263) summarises: "the users [of computer systems] are no longer mainly computer professionals, but are mostly discretionary users. As a result, designers are no longer typical of or equivalent to users; but the designers may or may not realise just how unique and therefore unrepresentative they are."

Even though computers have become both commonplace and indispensable, they still remain harder to use than they should be (Branscomb, 1983). This may be due to the above reason of designer versus user; it may be due to some other reason. Unfortunately, however, it is the norm rather than the exception to be an angry and frustrated user (Booth, 1990). Novice users feel irritated, insecure and even frightened when they have to deal with a system whose behaviour is incomprehensible, mysterious and intimidating and where they have to adapt to new concepts and associated jargon (Oborne, 1985).

Given the increased use of computers in all spheres of living and the obstacles of computer-usability the study of human-computer interaction (HCI) has become increasingly important (Booth, 1990). Generally defined as the study of the interaction between humans and computers, Booth (1990) divides HCI into five areas of study. These are shown in figure 1, and will be briefly described in the following paragraph.

Figure 1: A Representation of the different areas of study within HCI



HCI is concerned with present and new technologies regarding both input and output functionalities. It aims to develop *hardware and software* and to suggest where and in what situations these technologies and techniques might be put to best use. Second, HCI is the study of how users interact with computer systems. It is concerned with providing theories and tools for *modelling* the knowledge a user possesses and brings to bear on a task. Thus enabling designers to build more usable systems by making explicit the user's model of the task and system. Thirdly, HCI attempts to fulfil user's information needs and provide freedom to perform *tasks* in the way that they wish, without any excessive effort on his/her part. Fourth, HCI considers how *design* might be improved by taking more account of the user, thereby taking more account of the user. Finally, HCI is concerned with the impact that computers and new systems have on individuals and organisations thereby developing models that take the user into account more. Furthermore it aims to suggest design and implementation techniques that might reduce problems encountered with human-computer interaction within *organisations* (Booth, 1990).

Hence HCI attempts to optimise the reciprocal relationship between humans and computers. Yates (1989) stresses that designing the human-computer interface to optimally accommodate the users and the accomplishment of the task is essential.

Thus it can be seen that the study of human computer interaction has the potential to offer great insight into the psychology of humans and computers from the individual interaction in terms of software and hardware to the overall impact of computers on the organisation in general.

The literature review that follows focuses on three aspects of HCI – the cognitive aspect, in terms of mental models, the attitudinal aspect in terms of computer anxiety and finally the aspect of user prior knowledge and usage of computers, with the aim of outlining the bases for the present study. In so doing it is the intention of the present research to contribute to an understanding of both the attitudinal and the cognitive aspects of the first-time adult computer user, thereby providing an understanding that can be applied to the workplace and computer trainers alike.

CHAPTER 2: MENTAL MODELS

2.1. An introduction to the concept of mental models

In the past, Human Factors research concentrated on behaviour, and steered away from trying to understand its causes and effects (Lucas, 1987). On the other hand, Cognitive Psychology chose to focus on highly controlled laboratory tasks, rather than looking at real-task domains (ibid.). However, since much of the computer user's behaviour at the interface can be attributed to the cognitive strategy that the user has when attempting to complete the task, these two disciplines have had to both contribute to the understanding of human-computer interaction (Booth and Brown, 1990; Payne, 1992; Rogers, 1992b). The theory relevant to attempting to explain the cognitive processing involved in task completion in terms of computers is that of mental models (Borgman, 1986).

However, the term mental model has been adopted by a variety of professions and utilised to describe an assortment of notions, ranging from an image or mental picture, to an analogy, to qualitative simulations and even to task-action mappings (Rutherford and Wilson, 1992). Hence, while the phrase 'mental model' is ubiquitous in the literature, it is often used in quite vague terms (Bainbridge, 1992).

Kenneth Craik (1943) originally introduced the concept of mental models as internal constructions of an aspect of the external world that can be manipulated thereby enabling predictions as well as inferences to be made, although he didn't specifically use the term mental model. Norman (1983) elaborated upon Craik's idea and further stated that people's views of the world, of themselves, of their capabilities as well as the tasks they are to perform depend extensively on these conceptualisations that they bring to the task. These internal, mental models provide predictive and explanatory power for understanding the interaction (ibid.). Following on from this, a mental model is defined as:

> ...mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system function and observed system states, and predictions of future system states.
>
> Rouse and Morris, 1986, p351

Carroll and Olson (1988, cited in O'Malley and Draper, 1992, p73) have a similar definition of mental models, less succinctly stated but also quite explanatory:

> ...a rich and elaborate structure, reflecting the user's understanding of what the system contains, how it works and why it works that way. It can be conceived as knowledge about the system sufficient to permit the user to try out actions mentally before choosing one to execute.

One of the important distinctions made in the literature is the difference between mental models and conceptual models (Booth and Brown, 1990). Young (1983) contends that there are eight types of models covered by the phrase 'conceptual model', all similar to the 'mental model' concept defined above, and therefore he uses the terms interchangeably when referring to user's mental representations of their interactions with complex devices (Staggers and Norcio, 1993). However, Norman (1983) makes a clear distinction between mental and conceptual models. A *conceptual model* is what is invented by the designer, engineer, scientist or trainer as an accurate, complete and consistent model of the system, whereas a *mental model* is what the user has in his/her mind, it cannot be directly expressed and will always remain confusable and inexact to some extent (Norman, 1983; Borgman, 1986; Booth and Brown, 1990). Farooq and Dominick (1988) seem to concur with Norman's definitions by using the term cognitive model to mean a model, usually formed by a cognitive psychologist, which aims to describe the cognitive processes by which humans complete a task, thereby having a similar conceptualisation to Norman's designer's/ scientist's/ trainer's cognitive model. They also state that a mental model is the user's internal mental representation of the system (ibid.).

Norman (1983, 1988) further introduces the 'system image'. Ideally the user's mental model and the designer's conceptual model should be equivalent, however if these are not, the *system image* is the impression that the device portrays to the user: its physical appearance, its operation, the way it responds and the system manual and instructions that accompany it (Norman, 1988; Staggers and Norcio, 1993).

2.2. Nature of mental models

While some of the characteristics of mental models may have become apparent in the above discussion, it is now necessary to discuss the nature of mental models in more detail.

Firstly, Johnson-Laird (1980) notes that mental models are simpler than the entities that they represent and consequently are incomplete. Norman (1983) explains that the models that people have are neither precise nor elegant but rather are meagre, imprecisely specified and full of inconsistencies, gaps and idiosyncrasies. Moreover, people are often uncertain of their knowledge and mental models, even if they are complete and correct, and their mental models can very often include statements about the degree of certainty that they feel about their knowledge (ibid.). Norman (1983) has found that people can construct superstitions – rules that seem to work even if they don't make any sense – and these can be incorporated into the mental model. They can reinforce and govern behaviour and can enforce added caution when performing tasks (ibid.).

Another characteristic that Booth and Brown (1990) note is that mental models are very unstable. This can be noted by the fact that people forget details of tasks and systems. They also comment that the lack of firm boundaries between mental models can be illustrated by the fact that people can confuse similar devices with one another (ibid.).

In order to further conceptualise the nature of the concept of the mental model, it needs to be differentiated from that of knowledge (Rouse and Morris, 1986). Rouse and Morris (1986) state that it is reasonable to utilise the phrase for special types of knowledge. O'Malley and Draper (1992) concur by stating that mental models are a useful way of characterising the function of certain types of knowledge representation in interaction with devices and hence it appears as part of the definition above.

A further distinguishing aspect of the mental model is that it is thought to be dynamic, ever-changing with new knowledge and it can be "run" to test hypotheses about the devices behaviour (Borgman, 1986; O'Malley and Draper, 1992; Green, 1990). When appropriate, the mental model can be helpful, and at times essential, for dealing with the device, "but when inappropriate or inadequate can lead to misconceptions and errors" (Young, 1981, p51 cited in Borgman, 1986, p48).

2.3. Construction of mental models

Individuals form their mental models of systems by either interacting with the system interface or by observing others interacting with it (Borgman, 1986). The user interface design should therefore provide cues for the development of accurate and complete models (Eberts, 1988). At the same time, it is generally accepted that mental models are acquired and adapted through the interaction of a user with a specific device (Wærn, 1993). Ultimately, however, it is not known exactly how they are formed (Staggers and Norcio, 1993).

In addition to the above, it has been proposed that spatial information is used to construct mental models and also that pictures assist in construction and management of mental models (Thatcher, 1995; Glenberg and Langston, 1992). Taylor and Tversky (1992, cited in Thatcher, 1995, p10) in their study, found that users were developing mental models from three different mediums, namely: written instructions, spatial descriptions and from pictures.

Furthermore, Staggers and Norcio (1993) note that when first encountering a new domain, old knowledge is transferred. For instance, when they use a text editor, subjects spontaneously generate a typewriter model and because of this, certain misconceptions about text editors become evident (ibid.). Booth and Brown (1990) state that users recruit knowledge in blocks from perceived related domains, when appropriate, depending on the demands of the task.

Carroll and Thomas (1982, cited in Carroll and Mack, 1985, p39) further suggest that metaphoric comparisons such as "a text editor is a typewriter" can be used to structure learning of new devices. A metaphor, in this instance, refers to "kernel comparison statements whose primary function in learning is to stimulate active learner-initiated thought processes" (Carroll and Mack, 1985, p40). Thus educators can use the metaphors of typewriters and file cabinets to explain the workings of a computer system (Booth and Brown, 1990). These metaphors provide shortcuts to understanding complex units because they are utilising the person's existing knowledge (ibid.).

In comparison to the metaphor hypothesis, the analogy hypothesis proposes that people's understanding is structured in the form of analogies, that are partly from a knowledge base, for example an analogy of electricity being like flowing water (Staggers and Norcio, 1993; Gentner and Gentner, 1983). Halasz and Moran (1982, in Booth and Brown, 1990, p76) summarise by stating that an analogy is where a whole unknown system is considered to behave, in the same way as a known system, whereas a metaphor only suggests that part of the unknown system is similar to the known one. Carroll and Mack (1985) contend that metaphors have more use in aiding learning due to the fact that they can be applied to dissimilarities as well, whereas structured analogies cannot. However, according to Staggers and Norcio (1993) this may not be relevant because users will sometimes not reject the dissimilarities and/or inaccuracies in their models and hence whether they are analogies or metaphors is not relevant, and instead, the main issue is that they serve as mental model construction devices.

Kieras and Bovair (1984, cited in van der Veer, 1989, p1442) report empirical studies showing that only a certain type of metaphor may show improvement in the performance and learning of subjects. Van der Veer (1989) states that for the task level, functional metaphors may refer to known situations, systems and/or structures. On the other hand, for the syntactic level, metaphors often do not need to be constructed, but rather a description of formal grammar, jargon or a set of production rules will be needed (ibid.)

Booth and Brown (1990) believe that one of the central issues regarding metaphors is how to signpost the boundaries where the metaphors are no longer relevant, and where another is more appropriate. If adaptable metaphors can be proposed, they are useful tools for acquiring and adding new information for development of models of unfamiliar systems (ibid.).

It has been shown in the literature that training has an important impact on the development of mental models (Borgman, 1986). Carroll and Mack (1985) believe that the trainer should provide a conceptual model of the system as a basis for developing mental models. Although the user will still build a mental model with out it, it is likely to be inaccurate in the fact that it has only been built based on interaction (Fisher and Newcombe, 1990). Mayer (1989) confirms this by saying that the conceptual model helps to organise and integrate information and to foster meaning. However, Carroll and Mack (1985) state specifically that conceptual models are not metaphors; they sometimes can be too abstract to include metaphors.

The importance of the provision of a conceptual model and/or metaphors is however, as yet, unconfirmed. Halasz and Moran (1983, cited in Bibby, 1992, p156) found that when the experimental group were given information about the internal states of a device and the control were given procedures for operation, when exercises resembled those in the manual, no difference in performance was found. However, with novel sequences, the group with greater understanding of internal processing made fewer errors and took less time. Van der Veer (1989) found that success in using metaphors in learning was dependent on individual characteristics; that adoption of the metaphor was only found for imagers (those who absorbed the imagery of the metaphor).

Schnotz and Preuß (1997) found that in order to foster conceptual change, learning tasks should stimulate individuals to construct mental models and then utilise these mental models enough to detect conceptual deficits. In turn, conceptual change can be assisted through action as opposed to dictation of the metaphor. Wærn (1993) found that presentation of metaphors failed to produce superior performance times and as an alternative to provision of metaphors, she found a similar result to Schnotz and Preuß (1997), that being that users learnt more through the process of interaction and doing.

Borgman (1986), using an experimental methodology, found that, despite having trained some subjects with a certain analogy and some without, most subjects had some sort of model of the system with which they were interacting. Similarly, Shager and Klahr (1983, cited in Bibby, 1992, p158) showed that users are able to construct a model of the workings of a device in the absence of any instructions at all. This is pertinent to the present study in that it is hypothesised that the first time computer user will have a mental representation of what a computer is and how it functions without having interacted with a computer before. The subject will use his/her prior knowledge of 'computer-like' devices such as ATM's, cash registers and/or calculators, or alternatively, utilise knowledge of having watched another person operate a computer, such as in the library, in the bank or on the television in order to conceptualise the computer.

To date, no specific attention has been paid to individual differences in mental model construction. Van der veer (1989) proposes that experimental methodology, while it can offer a great deal to understanding, it also limits generalisation of ideas, as well as fails to recognise individual differences. With the exception of Briggs (1990), no study to date has attempted to isolate individual differences in mental model construction, albeit in terms of age, gender, home language, occupation or education. Instead, most studies have studied variables of knowledge, experience and prior use of computers. While these variables will be studied, demographics will also be analysed in order to ascertain whether indeed, as everyone to date has assumed, demographic differences do not influence construction of mental models.

In summary of this discussion, mental models are apparent even before interaction with a device. Individuals, it has been found, will either use knowledge of other, similar devices that they have encountered before to construct mental models when first interacting with objects or alternatively, they will construct them as a result of observing others doing so. Furthermore, mental models will change subsequent to interaction and it is debated in the literature whether provision of metaphors in the learning context will aid acquisition of mental models. The following study aims to further understand these issues.

2.4. Content and structure of mental models

Gentner and Gentner (1983) propose that mental models are organised structures consisting of objects and their relationships. Rutherford and Wilson (1989) state that it is tempting for ergonomists to view mental models in terms of analogue representations and as graphical rather than symbolic forms of these. Rouse and Morris (1986), on the other hand, believe that mental models are frequently pictorial or image-like.

Johnson-Laird (1980) further proposed that mental models could include abstract notions as well. Summarily, objects are related to perceptual entities and the structure is correlated with the structure of the situation or interaction that it represents (Staggers and Norcio, 1993).

It also has been argued in many texts that the complexity and abstractness of mental models increase with use; as one moves along the x-axis of the two-dimensional space that will be presented in Section 4.1 Figure 4, (Norman, 1988; diSessa, 1983; Greeno, 1983). Larkin (1983) specifically states that novices use representational models rather than abstract models. Furthermore when comparing how experts and novices access their models, Larkin (1983) found specific differences: with easy problems, experts used principles in an order based on mathematics if they solved the problem at all. In the difficult problem scenarios, those with more knowledge assessed whether the model could be completed without any contradictions before attempting any quantitative work (ibid.).

2.5. The importance of understanding mental models

While some of the significance of studying mental models has been explained in the above discussion, the remainder of this chapter will highlight the importance of understanding mental models more specifically.

The objective of the research into HCI has been to find ways of understanding user's mental models of systems as well as to provide suitable metaphors of the system to improve user learning (Booth and Brown, 1990).

It is also stated that understanding mental models can help in matching facilities that the system provides to the needs of the user (ibid.). Staggers and Norcio (1993) expand by stating that system design and the system image can be improved if designers are aware of the user's mental models. Thus conceptual models and mental models should ideally be congruent; designers should all the while still recognise that the mental model is only based on interaction with the system (ibid.).

Hollnagel and Woods (1983, cited in Fisher and Newcombe, 1990, p88) suggest that, although the models must be matched, the system's image should be dynamic owing to the fact that users display individual differences and tasks may change over time. The understanding of mental models can further aid in awareness of differences in user populations (Booth and Brown, 1990). For example, direction of design should include deliberation of secretaries and accountants possibly having different models of a particular task (ibid.).

Rowe and Cook (1995) state that incorporating mental model diagnosis and instruction into training programs will enhance worker's understanding and subsequent use of complex systems.

It has also been noted in the literature that certain differences in terms of prior knowledge and exposure to a device will influence the existence, construction, complexity of mental models (Larkin, 1983).

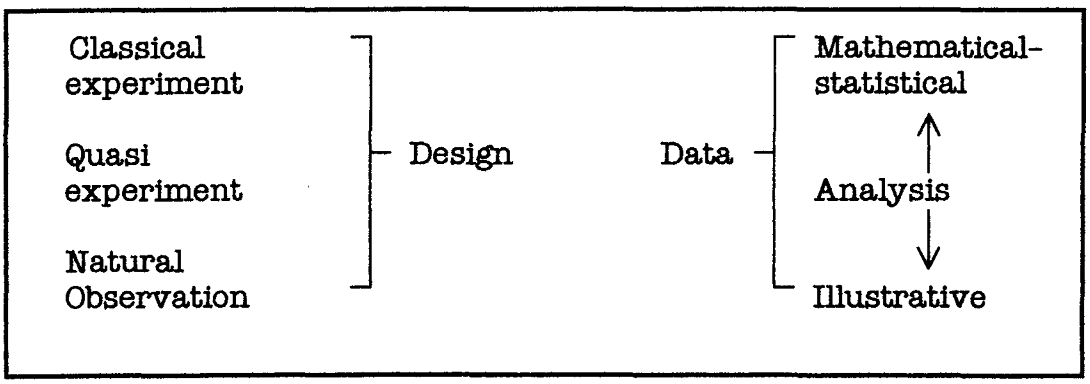
In a similar vein to the above, the purpose of the present study is to further understand the impact of a computer training program on mental models of first time adult computer users as well as to aid in the differentiation between the designer's conceptual model and the system image and the user's mental model of the computer. While no other study has attempted to analyse the impact of a computer course on mental models of first time computer users, several other studies have analysed mental models in other settings, for instance Denham (1993) studied the mental models of child computer users, most of whom had used computers before, Koping (1995) studied mental models of computer users in industry, Greyling and Thatcher (1997) studied mental models of student internet users and Briggs (1990) studied the mental models of women who were first time computer users without studying the impact of a training course.

2.6. <u>Elucidation of mental models</u>

Having discussed the definitions, conceptualisations and importance of mental models, it now becomes necessary to evaluate the methods of identifying mental models. More specifically, what are the methods available to the researcher for eliciting mental models? Norman (1983), when elaborating on the study of mental models very succinctly states: "you cannot simply go up to the person and ask".

There is extensive literature concerning the difficulties encountered when attempting to explain the nature of mental models (Norman, 1983; Rutherford and Wilson, 1992; Rouse and Morris, 1986; Sasse, 1992; Staggers and Norcio, 1993; Rowe and Cook, 1995). With mental models' research now having been around for about fifteen years, it becomes disconcerting that many authors cannot agree on the most effective method for elucidating mental models. Staggers and Norcio (1993) state that little of the methodology is reported in most studies, thereby authors are failing to assist other researchers who may endeavour to study mental models. Rutherford and Wilson (1992) present a simple diagram that outlines the features that determine the degree of formality of mental model identification studies.

Figure 2: Features determining the formality of mental model identification studies



Although labels are used on the left-hand (design) side of the diagram, Rutherford and Wilson (1992) believe that it is better to understand it in terms of a continuum of formality of design. On the right hand (data) side, it should also be seen as a continuum, this time of formality of analysis (ibid.). It is proposed that this diagram should be used merely as a guideline for understanding the respective standpoints that each experimental method is taking.

<u>Classical experimentation</u>

While the classical experimentation approach is the standard psychological methodological approach, and obtains the power to observe causality, researchers who have attempted to use this methodology when attempting to understand mental models have mainly provided information on conditions that are seen to influence mental models rather than the mental models themselves, for example Borgman (1986). Roberts (1993) also asserts that experiments limit the amount of information available to the experimenter; they fail to recognise individual differences in cognition and as a result limited and ungeneralisable conclusions can be drawn.

Quasi-experimentation: interviews

Interviews can be prone to retrospective distortions (Rutherford and Wilson, 1992). Furthermore, information can only be expressed verbally, and therefore when dealing with a structured mental model, this verbal expression may be limiting (ibid.). This criticism can also be applied to the most frequently used method of eliciting mental model information: verbal protocols (ibid.).

Natural observation: verbal protocols

The most common method of mental model elicitation to date has been that of verbal protocol analysis. Some debate as to their applicability is of some concern; Norman (1983) believes that verbal protocols, while they may be informative, are incomplete and may yield erroneous information in that a person may report one thing and act out another. Furthermore respondents are apt to giving information that the researcher wants to hear, based on their mental model of the researcher's expectations (ibid.; Rouse and Morris, 1986). Sasse (1992) also states that the shift from subconscious to conscious processing can change the nature and the processes of the model that one is trying to tap. On-line protocols, on the other hand, Norman (1983) believes to be more reliable in that they give descriptions of activities rather than explanations. Sasse (1992), however, states that the conceptualisation that is derived does not yield much information about a user's mental model.

Hockey (1990) believes that the success of the elicitation method depends on the representational form of the mental model. For instance, if it is verbal, protocols and interviews may well be successful, however, if it is visual, then this method could seriously distort the elucidation of the mental model. Prætorius and Duncan (1988) believe that verbal reports can still be useful as long as the subjectivity of the reports is kept in mind. Summarising, Rutherford and Wilson (1992) state that any information elicitation method that is to be used should be viewed in light of its particular limitations, biases and potential errors along with the specific goals of the study.

Moving on to the data side of figure 2, there have also been many problems with the data that has been produced in mental model studies. Borgman (1986), in an attempt to collect quantitative performance data, found that the relationship between the user's mental model and performance data was not straight forward, owing to the fact that most subjects had a model of the system, regardless of their experimental condition and only 4 out of 28 subjects explained the system according to the catalogue system analogy that was presented. Sasse (1992) concludes that the adoption and development of a mental model is both subjective and unique to each user, and therefore cannot be analysed in terms of performance data.

Sasse (1991) further asserts that the samples that have been employed in previous studies have been limited. Mostly so-called 'novice' undergraduate students have been studied and hence the ecological validity of these studies is questionable. Furthermore the sample sizes tend to be too small to be generalisable to the rest of the population (ibid.).

Finally Sasse (1992), upon conducting an experiment using five different scenarios investigating user's models, found that a user explaining a system was the most useful method for eliciting the user's conceptual knowledge of the system. The following research aims to use a similar method, but in view of the above review of verbalisations, the users will be required to use *drawings* to aid conceptualisation of the user's mental model. Denham (1993) initially used drawings to understand children's mental models of computers. Koping (1995) then utilised this procedure in a South African study of users' conceptualisations of computer dynamics and confirmed it to be very useful when users are able to communicate more effectively through the medium of drawing, when the drawings are annotated and when the drawings are accompanied by written explanations. The method of analysing users' drawings has also been used successfully in two more studies in South Africa whereby users have been required to draw their conceptualisations of the Internet (Thatcher and Greyling, 1996 and Greyling and Thatcher, 1997) with sample sizes of 51 and 200 respectively.

Having now elaborated on the area of mental models and the cognitive issues of human-computer interaction, the focus of the literature review will now move on to the affective, attitudinal side of human-computer interaction, before linking it back to the focus of this study, that being the first-time computer user.

CHAPTER 3: COMPUTER ANXIETY

> That queasy feeling in the stomach, the sweaty palms, the blank stare or preferring to watch over someone else's shoulder are all familiar to the first time computer user.
>
> (Knight, 1979, p74)

3.1. An introduction to the concept of computer anxiety

While a cognitive understanding of the first time computer user will provide relevant insight into computer users and how they conceptualise the computer, an understanding of their attitudes towards the computer is also important. It is essential for *both* of these aspects to be considered in design and training for these individuals who are encountering computers for the first time albeit in schools, tertiary institutions, as a consumer or in business.

"Computers have become an integral part of virtually every educational and industrial setting" (Cohen and Waugh, 1989, p735). When first exposed to computers, many people respond enthusiastically and are quick to master the skills necessary for the effective application of computers (Marcoulides, 1989). However, for many others, the computer represents a barrier to both educational and employment opportunities (Nordenbo, 1990). These people are known as "cyberphobes", "technophobes" or more commonly "computerphobics" (Rosen, Sears and Weil, 1987). For them, actual or imagined interaction with computers may cause disabling levels of anxiety and could undermine their self-confidence (ibid.).

Many terms have been used to describe user's negative psychological reactions to computers, for instance frustration, alienation, confidence and very often, anxiety and not surprisingly most of the measurements of these are essentially similar (Ray and Minch, 1990). Owing to the fact that it is the most commonly used term for this negative attitude, for the purposes of the following study, the term computer anxiety will be used to describe this negative emotional reaction to computers.

Simonson, Maurer, Montag-Torardi and Whitaker (1987; p238)) have defined computer anxiety as "the fear or apprehension felt by individuals when they use computers or when they consider the possibility of computer utilisation". Maurer and Simonson (1984, cited in Bozionelos, 1996, p995) then further defined computer anxiety in more behavioural terms: (i) avoidance of computers and areas where they are located (ii) excessive caution with computers (iii) negative remarks regarding computers and (iv) attempting to reduce the necessary use of computers.

3.2. Importance of studying computer anxiety

Extensive research has reported that successful computer-based information system implementation depends highly on positive reception from employees (Rainer and Miller, 1996). Attitudes towards computers are thought to influence not only acceptance of computers but also future behaviours; use of computers as professional tools or introducing computer applications into the classroom (Woodrow, 1991). Morrow, Prell and McElroy (1986) explain that negative attitudes exist for a variety of reasons, these inter-alia include the fact that they are afraid that the computer will take over because it can do many things more accurately and faster than a human, they are concerned that computers make personal information readily available to the public or that computers are so sensitive that pushing one wrong button will cause important information to be lost forever. The 'resistors' to computers indicate that they find computers dull, dreary, complex, unreliable, depersonalising, domineering and cold (Gilroy and Desai, 1986).

Improvement of work productivity that was anticipated with the introduction of computers is believed to be neutralised by the apprehension of organisational members to use the systems (Crable, et al, 1994; Bozionelos, 1996). One reason for this that has been proposed is that anxious managers rationalise their anxiety by forming the opinion that computers are not particularly useful (Charlton and Birkett, 1995). This can also be applied to students who display computer anxiety and are therefore disadvantaged in terms of course performance and consequently fail to acquire the computing skills required of job applicants (ibid.).

Teachers with negative affective states are less likely to choose to use computers in their teaching and these can then be unconsciously transferred to students through modelling (Bohlin and Hunt, 1995). Thus helping teachers to develop confidence and positive attitudes towards computers will give students more opportunity to acquire necessary computer skills needed more and more in careers today (Loyd and Loyd, 1985; Woodrow, 1991).

Understanding factors which influence computer usage would aid in development of training programs targeted at increasing individual's speed of adoption of computers and willingness to use computers (Crable et al, 1994).

It had been strongly stated in the literature that significant differences between novices and experts exist in terms of computer anxiety (Todman and Monaghan, 1994). Therefore it is proposed that, with exposure to computers and increased experience with computers, these novices will become less anxious (Ray and Minch, 1990; Marcoulides, 1988; Woodrow, 1991). Bearing in mind the afore-mentioned criticisms of sampling and definition, the following study aims to qualify that first time computer users do in fact exhibit computer anxiety when first encountering the computer, and whether this decreases (Reznich, 1996; Crable et al, 1994) or stays the same (Marcoulides, 1988) after the computer course.

3.3. <u>Research on computer anxiety</u>

Much of the computer anxiety research has focussed exclusively on the operationalisation and validation of the anxiety construct and the instruments to measure it (Crable et al, 1994) in comparison to other situation specific anxieties which have been based on specified theories or models and therefore detailed hypotheses to be tested (Glass and Knight, 1988).

One of the first studies to examine the interaction between computers and human users was conducted by Calhoun (1981) who found that the introduction of computers into the work environment resulted in extreme job dissatisfaction among employees (cited in Marcoulides et al, 1995, p805). Several more studies of this nature have found that computer anxiety is a significant variable for predicting computer achievement, and also that it influences the degree to which computers can be used effectively (Rosen et al, 1993; Marcoulides, 1988).

Unfortunately, most of the computer anxiety research, with very few exceptions, has focussed on samples of American college students, assuming group-invariant construct validity, with few attempts to examine different populations (Marcoulides et al, 1995). Examples of research on student samples include Morrow et al, 1986; Simonson et al, 1987; Ray and Minch, 1990; Glass and Knight, 1988; Cohen and Waugh, 1989; Harrington et al, 1990; Todman and Monaghan, 1994; Loyd and Gressard, 1984; Houle, 1996 and Zakrajsek et al, 1990. Additionally, very little is known about the attitudes and perceptions of individuals in the workforce (Marcoulides et al, 1995). The following research aims to provide insight into the South African population without using the more traditional student sample.

Fuller (1997) conducted a study on South Africans employed in the banking sector with the aim of understanding the influence of the individual characteristics of psychological type and cognitive style on computer attitudes. While some previous studies had attempted to understand these variables, actual personality measures had not been used as possible factors for quantifying variables such as external locus of control and cognitive style, which have previously been found to correlate with greater computer anxiety scores (Morrow et al, 1986; Igbaria and Parasuraman, 1989; Crable et al, 1994; Anderson, 1996). Fuller (1997) found that while the personality factors of Introversion and Extroversion (locus of control) had no relationship with computer attitudes, the Thinking/Feeling dichotomy (cognitive style) had a relationship with the computer attitudes of her subjects (N=190). However, she also considered that one of the limitations of her study was that it was a cross-sectional design, with only one measure of attitudes, and considered it important to study both the impact of a computer course on attitudes as well as to assess the stability of the computer attitude scores over a period of time. It is the intention of the following study to attempt to fulfil some of these suggestions for future research.

In addition to personality and cognitive style, several more predictor variables of computer anxiety have been proposed in the research and those that have not yet been discussed will now be covered in more detail.

3.3.1. Age

Igbaria and Parasuraman (1989) found that age significantly correlated with computer attitudes; older managers displayed more unfavourable attitudes towards computers than their younger colleagues did. Rosen and Maguire (1990, cited in Anderson, 1996, p65) conducted a meta-analysis of seventeen studies and found that age was a significant correlate of computer anxiety. This variable will be considered in the following study.

3.3.2. <u>Mathematics anxiety</u>

Morrow et al (1986), Barrow (1985), Rosen et al (1987), Loyd and Gressard (1984), Marcoulides (1988) and Igbaria and Parasuraman (1989) have all found computer anxiety to be positively related to mathematics anxiety. However, the relationship, while always significant, only accounts for a small proportion of the variation in computer anxiety (Loyd and Gressard, 1984).

3.3.3. <u>Gender</u>

The literature on computer anxiety also includes controversy as to whether gender influences the degree of computer anxiety exhibited. Owing to the fact that computer anxiety is highly related to maths anxiety, it has been postulated that a similar effect to that of maths anxiety will be exhibited, namely, that females will be more computer anxious than males (Igbaria and Parasuraman, 1989). However, results of gender differences have been inconclusive. Loyd and Gressard (1984), Cohen and Waugh (1989), Kernan and Howard (1990), Parasuraman and Igbaria (1990) and Todman and Monaghan (1994), for example, all found that there is no difference between males and females in terms of computer anxiety. On the other hand, Colley, Gale and Harris (1994) found that there was a very significant difference between males and females in computer anxiety. Owing to the debate over gender and computer anxiety, Whitley (1996) rigorously tested the gender differences in his study of computer-related attitudes. The study concluded that both men and women exhibited a low level of computer anxiety although the difference between men and women was significant. In addition, men and women both have low levels of negative attitudes towards computers; the women were again significantly different to the men in that they were not as low. Thirdly, it was found that computer experience did not influence gender differences in computer anxiety. Thus, the proposed study will be considering gender as an important demographic variable that could possibly influence computer attitudes and will aim to investigate the findings with regards to its influence on anxiety and other variables.

3.3.4. Treatment of computer anxiety

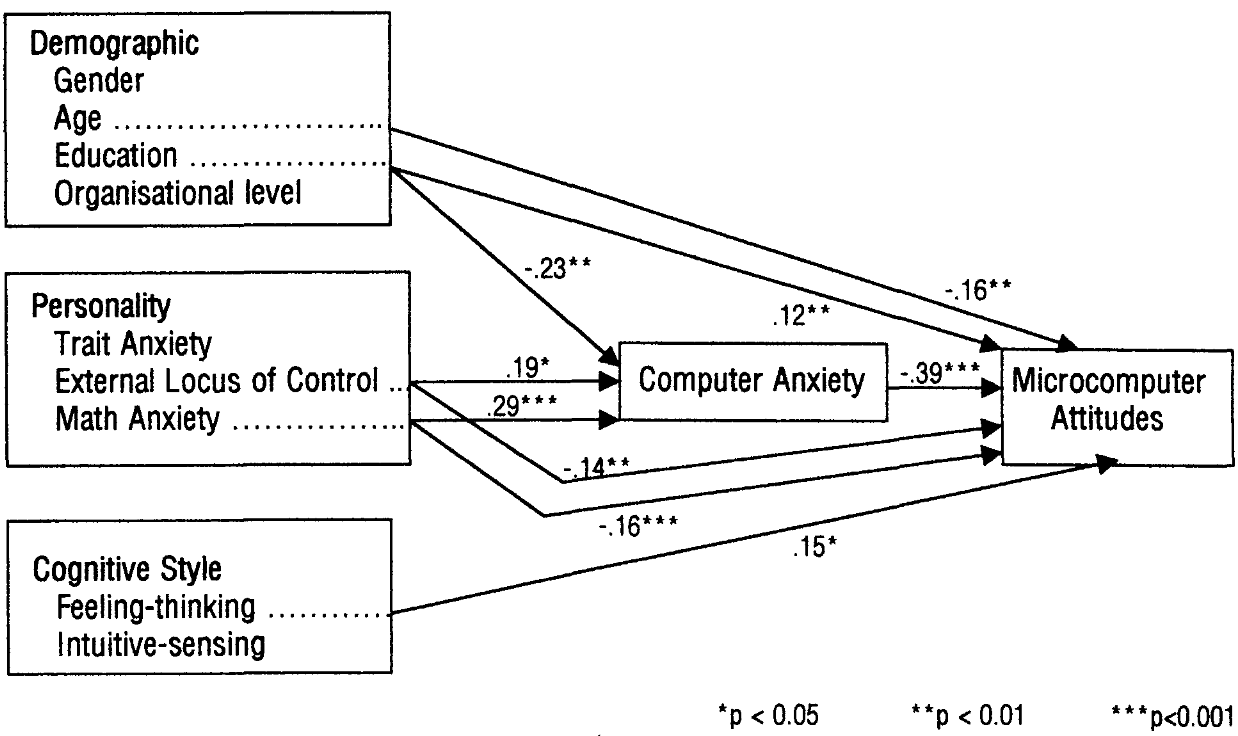
Some investigators have attempted to study methods of helping people overcome their computer anxiety (e.g. Bloom, 1985; Cambre and Cook, 1987; Howard, 1986; Howard and Thomas, 1987; Weil, Rosen and Sears, 1987, cited in Reznich, 1996, p247). Rosen, Sears and Weil (1993) conducted a longitudinal study of computerphobics and utilised clinical methods such as individualised relaxation training, systematic desensitisation, cognitive-behavioural thought-stopping and support groups in order to reduce computer anxiety. Very positive results were reported with the participants changing from being computerphobic to being eager to seek further positive computer experiences (ibid.). Reznich (1996) conducted a study comparing two different types of instructional methods. While a minimalist principles instruction treatment, showed immediate reduction in computer anxiety after the treatment, the control group, who were also given instruction, also showed a significant decrease in anxiety, however it was only after the second instructional session (one month later).

In a similar vein, the following study aims to study an instructional session and ascertain whether controlled exposure to computers will reduce anxiety shown when initially confronted by computers. Marcoulides (1988), however, found in his study, that computer anxiety did not decrease when students attended a computer course.

3.3.5. Models of computer anxiety

Igbaria and Parasuraman (1989) have been the only researchers to date who have made a tentative attempt to propose a model for computer anxiety. The researchers conducted a path analysis using least square regression on the model which is found below in figure 3. All the original factors of the model are shown, however, only the significant path correlation coefficients are illustrated where relevant. According to Igbaria and Parasuraman (1989) there was a conceptual distinction between computer anxiety and computer attitudes; computer anxiety was seen to be a predictor of overall attitudes and they differentiated between them with the aim of isolating whether in fact these could be differentiated as different (as opposed to synonymous) concepts.

Figure 3: Direct effects of individual characteristics on computer anxiety and attitudes toward microcomputers



3.4. Measuring computer anxiety

Throughout the past decade, several researchers have attempted to examine the interaction between computers and human users (Marcoulides et al, 1995). Researchers have used two different types of measures to study the complex array of emotional reactions which the use of computers, or even the thought of them, can invoke (King and Bond, 1996). The first type includes measures of physiological changes, such as blood pressure, pulse rate and respiration rate while the second type includes the more common self-report measures typically using three to six category Likert scale questions (ibid.).

A plethora of computer attitude instruments exist in the literature (for example Loyd and Gressard, 1984; Raub, 1981; Rosen, Sears and Weil, 1987; Kernan and Howard, 1990; Simonson et al, 1987; Marcoulides, 1989; Cohen and Waugh, 1989; Nickell and Pinto, 1986; Charlton and Birkett, 1995; Bohlin and Hunt, 1995 and Glass and Knight, 1988) and a bulk of the research on the concept itself is taken up in the validation of these scales (Szajna, 1994).

Rainer and Miller (1996) state that researchers have measured as many as fifteen different constructs with respect to computer attitudes, often without the necessary theoretical justification. These scales are limited by the fact that they are designed for specific populations and their diversity make it difficult to integrate the findings across the studies (Igbaria and Parasuraman, 1989).

Much of the research that has been described in the previous section has used a different measure for computer attitudes in each case. However, some measures have been found to be reliable, non-discriminatory in terms of gender, have undergone extensive development, have been tested repeatedly for reliability and are widely used. One of these is the Loyd and Gressard (1984) Computer Attitude Scale. It incorporates three sub-scales, namely:

Computer Anxiety, Computer Confidence and Computer Liking. Loyd and Gressard (1984) define computer anxiety as fear or anxiety towards computers, computer confidence as confidence in one's ability to use or to learn to use computers and computer liking as liking of computers or enjoyment of them. Each subscale contains ten four-point likert scale questions and a total computer attitude scale is calculated as a sum of the three sub-scales (Woodrow, 1991). The differentiation between the three attitude components is based on the premise that attitudes are multifaceted constructs, composed of several related constructs and therefore it is useful to differentiate between them (Carver, 1989; LaLomia and Sidowski, 1993).

Summation

Thus the discussion has now focussed on two aspects of human computer interaction. First it focussed on the cognitive aspects of user encounters with computers, and then the attitudinal aspects were elaborated upon. To bring together this literature review, therefore, it is now necessary to focus on the aspects of knowledge and usage of computers thereby concluding the presentation of the literature relevant to this dissertation.

CHAPTER 4: KNOWLEDGE AND USAGE IN TERMS OF COMPUTER USERS

4.1. Definitional aspects of knowledge and use

Having defined the cognitive and attitudinal aspects of the research that follows, it is now necessary to bring the focus back on to the essence of the present research; to expand on precisely what is lacking in terms of an understanding of the first time computer user.

First we will explore the definitional aspects of knowledge and usage in terms of computer users and how an understanding of these concepts need to be expanded for the purposes of this study.

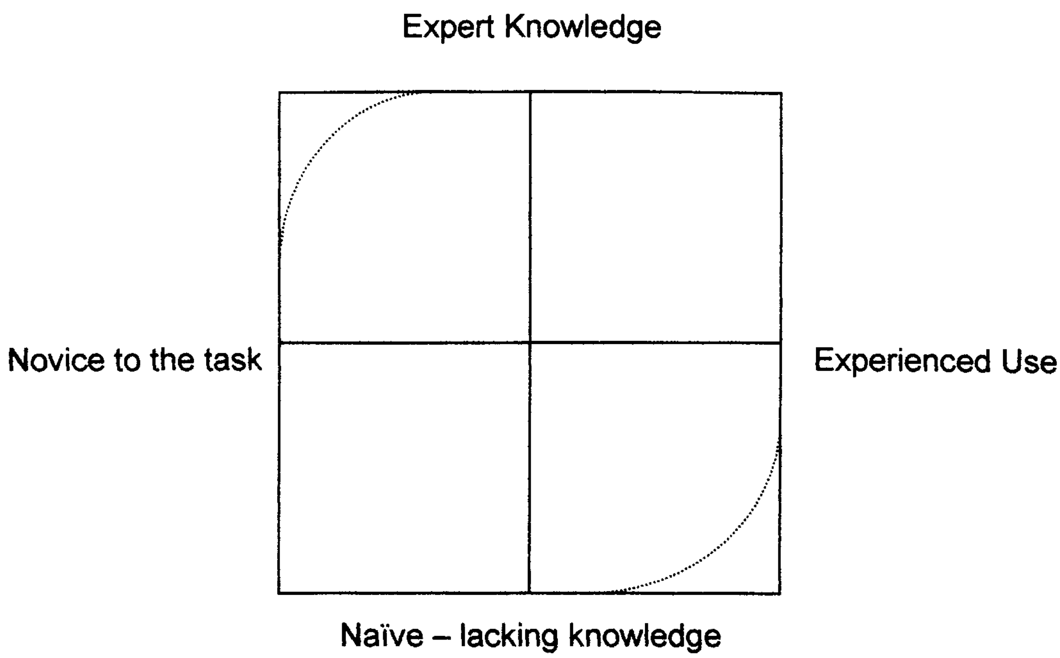
Besides defining, and subsequently designing, according to the experience of the user, the ergonomist should also understand how the user reasons about complex mechanisms such as computers (Borgman, 1986). In so doing, the knowledge can be used to both design systems around 'natural' human thought processes and to improve training mechanisms (ibid.).

"More and more people, inexperienced with computers are required to interact with them in their daily work" (Allwood, 1986, p633). Bearing this in mind, researchers have focussed on various differences between novice and experienced users. In a similar vein, the aim of the present study is to evaluate change in computer anxiety and mental models of the first time adult computer user before they begin a computer course and subsequent to completion. Fisher (1991) explains that the analysis of alternative user types has three functions: to enable system designers to understand and therefore to better provide for the different user types, to develop training sessions around users and to have reasonable task expectations of the computer user. However, Fisher (1991) also argues that pertinent aspects of terminology definition have been neglected in previous research and hence generalisability of research has been limited and furthermore that the above proposed understanding has not been accomplished.

More specifically, the use of the term novice user has been used by researchers to describe a wide variety of users from very experienced users, yet 'novices' to the experimental task, to school children who have never had computer classes at school (novices) when compared to those who have (expert) (Fisher, 1991; Denham, 1993). In the latter example, Denham (1993) does not consider whether the subject has access to a computer at home or in any other environment other than that of school and it is therefore questionable how 'novice' the school children actually are.

Fisher (1991) elaborates on the distinctions between novice and naïve, and experienced and expert users. Firstly, a *novice* user is one who is new or inexperienced in a certain task or in a given situation. The *naïve* user, on the other hand, generally denotes a person who is regarded as lacking developed powers of analysis, reasoning or critical capability in a particular situation. For instance, (s)he may use the computer for certain tasks, however (s)he does not need (or wish) to develop knowledge of the operating system. Furthermore, an *experienced* user is one who has developed extensive knowledge and skills through exposure or participation, however, the quality of the experience is not necessarily high, it is just more than the novice user. In comparison, the *expert*, as a direct opposite to the naïve user, is one who gains and substantially uses knowledge and skills about the dynamics of the operating system. (See Figure 4 below for these four terms depicted two-dimensionally).

Figure 4: Two-dimensional conceptual space for user characteristics



Thus to return to the criticism of previous research, many studies have administered questionnaires to university students and classified the difference between the experienced and the novice user as one who has or has not been on a computer course before respectively (for example Colley, Gale and Harris, 1994; Marcoulides, 1988). According to Fisher's model, the experience of the subjects could very easily not fall under the novice category and would more likely fall between novice and experienced, especially considering the fact that they could possibly have experience in computers in terms other than a course, for instance using a computer extensively at home or having taught themselves.

Thus, by way of example, it has been shown that past research has attempted to elaborate on contrasts between novice and expert users in order to recognise the essential differences between the needs and conceptualisations of the different computer users. However, owing to the fact that the researchers often fail to elaborate on the extent of computer knowledge and experience, the research cannot be fully generalisable.

4.2. The necessity to understand knowledge and usage

Having defined and explained the different types of computer usage, it now becomes necessary to expand upon the necessity to explore computer usage when it is recognised that computer prevalence in schools and organisations is extensive (Szujna, 1994). From the fact that at the beginning of the 1980's it was recorded that 50% of the working population of the West were employed in areas of processing and presentation of data and information, one would expect people to be familiar with and comfortable with computers, especially considering that it is the general feeling that computers are here to stay (Nordenbo, 1990; Harrington, Elroy and Morrow, 1990). However, in present day South Africa, this is not the case and several reasons have been postulated as to why this is so.

In South Africa, the prevalence of computers is not as extensive as that of the West. Owing to the fact that it is still an industrially developing country, access to computers in schools is limited and an extensive amount of the population have not, as yet, had the opportunity to sit in front of a computer at all. Thus general knowledge of computers is not as substantial as developed countries.

Secondly, for the adults and young people who missed out on the classes in computer studies, the opportunity to participate in future societal development now depends on the year of one's birth, rather than the level of one's education (Nordenbo, 1990). Thus, even though an increasing number of employees are expected to use computers in their work, they may not have had the opportunity to study them in school, and therefore are having to learn something new at a relatively late stage (Harrison and Rainer, 1992).

Furthermore, it has been increasingly found that white-collar workers and managers are reluctant to use computers as aids to managerial decision-making (Cohen and Waugh, 1989; Igbaria and Parasuraman, 1989). While often accepting computers as a product of advancement and recognising their potential capacity to improve organisational performance, actual attitudes towards these machines are not as positive as one would expect; some individuals express concern about the impact of these machines on their lives (Marcoulides, Mayes and Wiseman, 1995). Thus the potential gains are often neutralised by unwillingness of organisational members to use the system, by their apprehensions and negative attitudes towards computers (Crable, Brodzinski, Scherer and Jones, 1994). It has also been found these fears bring about a motivational barrier for learning (Reznich, 1996).

From this, with the increasing need for employees to be computer literate and because familiarity with computers these days is becoming a requirement for success in most fields, it is becoming even more important to understand the effects that changes in computer knowledge and experience have on users' computer anxiety towards computers and their conceptualisation thereof with specific reference to the first time adult computer user and his/her interaction with computers in a controlled, computer course environment (Bozionelos, 1996).

CHAPTER 5: SUMMARY AND HYPOTHESES

5.1. Summary

> In the past two decades, computers have become an integral part of modern society. From computerised answering machines to automated banking, computer technology is here to stay.
>
> Marcoulides et al, 1995, p804

However, despite the proliferation of computers, in schools, homes and in business, novice users are still finding them harder to use than they should be (Branscomb, 1983). Furthermore, extensive research has reported that successful computer-based information systems in organisations depend highly on a positive reception from employees (Rainer and Miller, 1996).

Various studies have investigated both the measurement of this negative attitude (usually called computer anxiety) as well as the possible variables that influence it. These have ranged from more permanent variables such as age, gender and cognitive style to more dynamic variables such as knowledge and usage of computers and access to computerised devices. However, previous research to date has also been inconclusive, has usually been aimed at validating a new attitude instrument, and often test administration is limited to a student sample.

In line with the need for development of knowledge about user's attitudes towards computers, the potential impact of training attitudes, also needs to be explored, with the potential to provide information on the effective integration and acceptance of computers into the evolving workplace (Crable et al, 1994).

Additionally, an understanding of the user's mental conceptualisation (his/her mental model) of the computer can also aid effective computer training. More specifically, if computer trainers understood how mental models develop, how to improve development of accurate mental models in training sessions, what the influence of prior knowledge and use of computers is on mental model construction and development, as well as how the complexity of mental models change as a result of training, more effective training procedures will be developed and consequently a greater understanding of human-computer interaction will be achieved.

Based on these arguments, the following research aims to elaborate on the understanding of the hypotheses stated below.

5.2. Hypotheses

Hypothesis 1: There will be a positive relationship between computer knowledge/usage and computer attitude scores.

Hypothesis 2: Computer attitude scores will significantly vary according to gender, with females exhibiting more negative attitudes towards computers than their male counter-parts.

Hypothesis 3: Computer attitude scores will significantly vary according to age, with older subjects exhibiting more negative attitudes towards computers than younger ones.

Hypothesis 4: Post-intervention measures for computer anxiety will decrease, and liking, confidence and overall attitude of respondents will increase when compared to prior-intervention measures for those respondents taking a computer course and in a similar vein, those that do not take the computer course will stay significantly the same.

Hypothesis 5: Mental model conceptualisations will change in terms of greater complexity after interacting with the computer in the course.

Hypothesis 6: The subjects will have a mental model of what a computer is without having interacted with a computer before. The subject will use knowledge of other 'computer-like' devices such as ATM's, cash registers or calculators, or alternatively utilise knowledge of having watched another person operate a computer, such as in the library, in the bank or on the television to conceptualise a computer.

Hypothesis 7: Mental model complexity will vary significantly according to prior knowledge and usage of computers in terms of the greater prior knowledge of computers, the more complex the mental model will be.

Hypothesis 8: Mental models of the experimental group will be significantly different from that of the control groups' subsequent to the computer course, with the control groups' conceptualisations staying the same as before.

PART TWO – THE PRESENT RESEARCH

CHAPTER 6: METHODOLOGY

6.1. Chapter Summary

This chapter outlines the present study in terms of the research design and procedure, the sample that was tested and the instruments that were used. It also delineates the statistical techniques that were used and the theoretical bases for the utilisation of these methods.

6.2. Research Design and Procedure

In order to fully operationalise a study of the variables discussed in the literature review, namely: demographics, prior knowledge and usage of computers, computer anxiety and mental models of subjects before and after a computer course, a research design that was conceptually sound and one that would eliminate many alternative hypotheses in its approach, was deemed necessary. Owing to the fact that random sampling was not possible due to the fact that respondents were to attend a computer course, an ex post facto, matched-pairs with control group field research design was believed to be the most appropriate. Thus while non-random assignment of subjects occurred, they were tested prior to, and after an intervention, in this case a computer course. Furthermore, to further analyse the impact of the course as well as the test-re-test biases encountered with matched pairs designs, a control group was included in the study.

A variety of researchers have called for a sound research design when analysing the effects of a computer training program, when assessing the effects of these on attitudes and mental models as well as the effect that the measurement of these constructs leads to their significant occurrence in subjects (Fuller, 1997; Houle, 1996; Koping 1995; Denham, 1993). Furthermore the influence of knowledge and prior usage or interaction of computers has been debated within the literature with reference to the degree of knowledge and usage and how these will impact on course structure, mental models as well as attitudes of individuals (Wærn, 1993).

In line with the critical concern expressed by Norman (1988, p155) that "there is no substitute for the interaction with the actual study of users", the researcher aimed to access a representative sample of the population in preference to a student sample, and therefore contacted several companies running basic skills in computing courses, and obtained access to one of them. The company ran two 'introduction to computers' courses, one being a "Computers Made Easy" course and the other a "Windows '95 for Beginners" course. The reason for adopting subjects from beginners courses was that these courses were considered to have a suitable range of respondents in terms of prior exposure to computers and usage thereof as well as attitudes towards computers to gain understanding of the influence of the course on these variables as well as mental models.

Prior to the course commencing the course presenter introduced the research topic and questionnaires were distributed to members of the class. Participation was entirely voluntary, and this was emphasised in the covering letter from the researcher. This letter also delineated the existence of the follow-up questionnaire and mentioned that the participant would be asked to fill it out at a later stage. Thus names and contact details of participants were requested at this time. After completing the questionnaire (approximately fifteen to twenty minutes), respondents handed them back to the course presenter and these were in turn collected by the researcher. Courses were run on a single day basis, approximately every three weeks, depending on demand. Six to ten people attended each course.

After three weeks the researcher attempted to contact the participants by telephone and requested their participation in the follow-up study. This three week period was considered to be sufficient time for the respondents to interact with computers subsequent to their course, yet not specifically remember their answers to the questions they had been asked on the previous occasion.

In order to eliminate subject and experimenter artefacts, a control group of respondents was also included in the study, those who did not attend a Basic Skills in Computing course. These respondents were approached randomly to fill out the questionnaire and then, in a similar time span as that of the experimental group, were asked to fill out the follow-up questionnaire, thus providing the opportunity to analyse the influence of the computer course in more detail.

6.3. Sample

The initial sample size consisted of sixty two subjects with a response rate of 77% and the follow-up sample size was thirty three subjects, therefore having a response rate of 53% with respect to responses prior to the computer course. The control group consisted of eleven subjects. They were recruited from a pool of the researchers contacts with companies who had employees who would be eligible for attending a computer course and were selected purely on the basis of being similar in demographic respects to the sample.

While the researcher recognises the relatively small sample size, the response rate was exceptionally high and the usage rate of questionnaires was also good. Furthermore with both pre- and post-test samples having a size greater than thirty, thus approaching normalcy and therefore eliminating sampling bias in terms of the Central Limit Theorem (McCall, 1990), the researcher felt confident that the results would be reflective of the population. The pre-course sample demographics are presented in Table 1 below.

Table 1: Sample demographics by frequency and percentages

Variable	Group	N (62)	Percent
Gender	Males	20	32.3
	Females	42	67.7
Home Language	English	36	58.1
	Afrikaans	2	3.2
	Zulu	11	17.7
	South Sotho	3	4.8
	North Sotho	1	1.6
	Venda	3	4.8
	Tswana	3	4.8
	Xhosa	1	1.6
	Italian	1	1.6
Marital Status	Single	17	27.4
	Married	37	59.7
	Divorced	4	6.5
	Widowed	1	1.6
	Community of Property	1	1.6
Education	Std 8	5	8.1
	Std 10	24	38.7
	Diploma	14	22.6
	Degree	15	24.2
	PGrad Degree	0	0

Table 1 Continued: Sample demographics by frequency and percentages

Variable	Group	N (62)	Percent
	Not working	6	9.7
Occupation	Student	2	3.2
	Entry level position	18	29.0
	Middle Management	14	22.6
	Senior Management	8	12.9
	Professional	8	12.9
	20 yrs or less	3	4.8
Age	21 yrs – 30 yrs	12	19
	31 yrs – 40 yrs	20	32
	41 yrs – 50 yrs	11	18
	51 yrs – 60 yrs	9	15
	61 yrs – 70 yrs	4	6
	71 yrs or more	1	1.6

In order to conduct statistical analyses, the age variable was categorised, except when conducting the correlations. The maximum age of the sample was seventy-two with a minimum of nineteen and a mean of 40 years (sd=13.68). Additionally, cluster analyses (technique reviewed later in 6.4.2.), was used to categorise the levels of occupation of respondents thereby resulting in discrete, as opposed to continuous, data sets. As one can see in the above table, occupation was categorised into six subsets, namely: not working (such as retired or home executive), student, entry level job (included typist, data capturer, admin clerk), middle management (included travel consultant, supervisor, inspector); senior management (HR director, Marketing manager, Senior Personnel officer) and professional (engineer).

Table 2 which follows shows the demographics of the follow-up sample. For ease of comparison, percentages for the pre-intervention sample are also shown.

Table 2: Post-intervention sample demographic frequencies and percentages

Variable	Group	N (33)	Percent	Pre-Int. %
Gender	Male	10	30.3	32.3
	Female	23	69.7	67.7
Home Language	English	17	51.5	58.1
	Afrikaans	0	0	3.2
	Zulu	8	24.2	17.7
	South Sotho	2	6.1	4.8
	North Sotho	0	0	1.6
	Venda	2	6.1	4.8
	Tswana	2	6.1	4.8
	Xhosa	1	3	1.6
	Italian	1	3	1.6
Marital Status	Single	12	36.4	27.4
	Married	19	57.6	59.7
	Divorced	2	6.1	6.5
	Community of Property	0	0	1.6
Education	Std 8	5	15.2	8.1
	Std 10	16	48.5	38.7
	Diploma	8	24.2	22.6
	Degree	4	12.1	24.2
	PGrad Degree	0	0	0
Occupation	Not working	2	6.1	9.7
	Student	0	0	3.2
	Entry level position	18	54.6	29.0
	Middle Management	8	24.2	22.6
	Senior Management	3	9.1	12.9
	Professional	2	6.1	12.9

Table 2 Continued: Post-intervention sample demographic frequencies and percentages

Variable	Group	N (33)	Percent	Pre-Int. %
	20 yrs or less	0	0	4.8
Age	21 yrs – 30 yrs	7	21	19
	31 yrs – 40 yrs	15	45	32
	41 yrs – 50 yrs	6	18	18
	51 yrs – 60 yrs	4	12	15
	61 yrs – 70 yrs	1	3	6
	71 yrs or more	0	0	1.6

For ease of review, the control group's demographic details are presented in Table 3 below.

Table 3: Control Group demographic frequencies and percentages

Variable	Group	N (11)	Percent	Pre-Int. %
	Males	5	45.5	32.3
Gender	Females	6	54.5	67.7
	English	7	63.6	58.1
Home Language	Afrikaans	0	0	3.2
	Zulu	1	9.1	17.7
	South Sotho	0	0	4.8
	North Sotho	0	0	1.6
	Venda	0	0	4.8
	Tswana	0	0	4.8
	Xhosa	3	27.3	1.6
	Italian	0	0	1.6
	Single	6	54.5	27.4
Marital Status	Married	5	45.5	59.7
	Divorced	0	0	6.5
	Widowed	0	0	1.6

Table 3 Continued: Control Group demographics by frequency and percentages

Variable	Group	N (11)	Percent	Pre-Int. %
Education	Std 8	1	9.1	8.1
	Std 10	1	9.1	38.7
	Diploma	5	45.5	22.6
	Degree	2	18.2	24.2
	PGrad Degree	2	18.2	0
Occupation	Not working	2	18.2	9.7
	Student	2	18.2	3.2
	Entry level position	3	27.3	29.0
	Middle Management	2	18.2	22.6
	Senior Management	1	9.1	12.9
	Professional	1	9.1	12.9
Age	20 yrs or less	1	9.1	4.8
	21 yrs – 30 yrs	4	36.4	19
	31 yrs – 40 yrs	2	18.2	32
	41 yrs – 50 yrs	2	18.2	18
	51 yrs – 60 yrs	1	9.1	15
	61 yrs – 70 yrs	1	9.1	6
	71 yrs or more	0	0	1.6

6.4. Instruments

6.4.1. Demographics

The questionnaire comprised three different instruments. The first involved a demographics form, outlining the subjects' name, date of birth, gender, home language, marital status, highest education level and occupation. A tick list of having seen, used or owned a selection of electronic devices was then given including: typewriter, calculator, cash register, ATM, video games and computers. The respondent was then asked to describe his/her previous interaction with computers, with the aim of expanding on the respondent's knowledge and experience of computers (Questionnaire can be found in Appendix A).

6.4.2. Computer Attitude Scale

The next section contained Loyd and Gressard's (1984) Computer Attitude Scale (CAS) which aimed to glean the subject's attitudes towards computers. The scale consists of thirty items that are rated on a four-point likert scale which add up to a total computer attitude rating. It also separates into three ten item sub-scales, namely: computer anxiety (fear or anxiety towards computers), computer confidence (confidence in one's ability to use or to learn to use computers) and computer liking (liking of computers or enjoyment of them). The items on each sub-scale are mixed and distributed throughout the instrument. The items are both positively "I would feel at ease in a computer class" (anxiety) and negatively worded "I am not the type to do well with computers" (confidence). In order to eliminate response tendencies, fifteen of the items are content reversed.

In response to the statements, subjects indicate which one of the four ordered responses, from strongly agree to strongly disagree that they feel is most appropriate for them. The responses to positively worded items are coded so that strongly disagree=1, disagree=2, agree=3 and strongly agree=4. A higher score therefore corresponds to a more positive attitude towards computers overall as well as greater confidence and liking and less anxiety.

The primary bases for selection of the measuring instrument was that it was a reliable and valid measure that had been used in South Africa before.

Woodrow (1991) describes the CAS as the most extensively used and tested of all computer attitude scales. Fuller (1997) utilised the CAS to analyse computer attitudes of employees in the South African banking environment and reported good coefficient alphas of: 0.83, 0.85, 0.85 and 0.93 for the anxiety, liking and confidence sub-scales and the total attitude scale respectively. Loyd and Gressard (1984) originally reported alpha coefficients of 0.86, 0.91, 0.91 and 0.95 respectively. Furthermore other international studies have concurred with these reliabilities (Loyd and Loyd, 1985; Koohang, 1989; Dukes, Discenza, and Cougar, 1989; Woodrow, 1991; Dyke and Smither, 1994 and Busch, 1995). No studies have reported test-re-test reliabilities for this scale.

Owing to the fact that only one other study has utilised this instrument in South Africa before, the present study aims to influence the understanding of the reliability and validity of computer anxiety scales on samples in Industrially developing countries, as well as utilise the test-retest reliabilities to further substantiate its use, generally (LaLomia and Sidowski, 1993).

6.4.3. Mental Model Drawings

The final section of the questionnaire was aimed at assessing the respondent's mental model of the computer. As discussed in the literature review section (Section 2.6.) and considering that the respondents had varied encounters with computers, drawings were argued to be an appropriate method of mental model elicitation. Therefore, the respondents were asked to draw what they perceived was "under the lid of the computer box".

This research question is the same one that was used in Koping's (1995) study and was perceived to be general enough for a first time user to apply his/her previous encountering with computer-like devices to the problem, without bias towards those who had a little more knowledge or use of computers prior to the course. As recommended by Koping (1995), respondents were asked to label their drawings and to write a brief description of what they had drawn and it was stressed that there was no 'right' or 'wrong' answer. In accordance with the literature, respondents were expected to have no conceptual idea, to utilise knowledge from other related devices or from watching others using computers or, alternatively, their conceptualisations would stem from their previous use of computers. While not specifically asking for functionality of computers (such as saving a file), it was believed that respondents would be able to associate certain functions of the computer with actual internal aspects of the computer (such as turning it on and off meant that it required power or that saving a file indicated that it had some sort of memory). While Koping (1995), in her study, asked respondents to also draw the computer performing the process of saving a file, it was believed that for first time computer users, this would possibly impose limits on a person who had only seen others using a computer and therefore was not aware of the fact that it could save a file. This issue will be addressed in further detail in the discussion of results chapter.

The follow-up questionnaire (in Appendix B) was essentially the same as the first one, however it did not require the same demographic information already gleaned from the previous questionnaire. Instead, it required information about the amount of time that the participant had spent on the computer since his/her computing course and the reason for this use or lack thereof as the case may have been.

6.5. Data Analyses Techniques

The present research used qualitative and quantitative research methods thereby producing both discrete data (for instance mental models categories) as well as continuous data (attitude scores and age). Bearing this in mind, the following data analysis techniques were employed:

6.5.1. Descriptive Analyses

In Section 6.2, elaborating on the demographics of the sample, information was presented in the form of frequencies and measures of central tendency, where appropriate. These measures provide a great deal of information with regards to demographic data as well as categorised data and are important tools for behavioural research (Kerlinger, 1986).

Further descriptive data will be presented in the form of frequency histograms in order to give the reader graphic representations of comparisons that are being made and sample distributions. The horizontal axis (the abscissa) indicates the midpoints of the intervals or to the category, and the vertical axis (the ordinate) depicts the frequency with which scores correspond to the categories on the abscissa (McCall, 1990).

6.5.2. Cluster Analyses

Cluster analysis is a generic term referring to a wide variety of techniques which separate data into constituent groups (Rosenthal and Rosnow, 1991). They are used to transform data into specific groups, categories or clusters of similar entities, thereby reorganising a large sample of data into relatively homogenous groups. These groups are not formed a priori, but rather are dictated by the data.

It was on the basis of necessity for data to be reduced into summarised clusters in order to ascertain similarities and differences and relationships within the categories as well as with other variables, that correspondence analysis, a specific form of cluster analyses was deemed to be an appropriate statistical technique. Thus it was used to categorise responses to the computer knowledge and usage question, the occupation question as well as to group drawings of mental models. However, cluster analysis does result in some difficulties that need to be overcome. Firstly, if only one person categorises the data, it will be a subjective rating and categories could very well be different to that of another person, should (s)he have interpreted the data. This issue was addressed by utilising two independent raters to interpret the data. Secondly, in order to take possible subjectivity of ratings into account, inter-rater reliabilities need to be calculated to ensure categorisation between raters is sufficiently similar. Cohen's Kappa, which is a statistic that indicates the agreement between raters after chance agreement has been removed (Rosenthal and Rosnow, 1991), was generated for the raters' classifications of both pre-intervention's computer knowledge and usage variable and mental model variable, resulting in a measure of $\kappa=0.73$ and 0.79 respectively (both highly statistically significant with $p < 0.00$).

The procedure employed when categorising the data was as follows. First the raters worked through the data independently, each thereafter proposing a possible categorisation system that would define the data in the best possible way. Data analyses categories were then debated, defined and agreed upon. The raters then went through the data again independently, categorising it according to the agreed upon groups. The raters then compared categorisations, establishing whether definitions of categories were specific enough so as not to generate too many differences in categorisations. Once these were re-defined, the raters returned to the data to re-code it a final time according to these latest definitions. The Cohen's Kappa that was calculated was generated for these final ratings.

6.5.3. Pearson's Product Moment Correlation Coefficients

Correlation is a statistical technique used to determine both direction and strength of a linear relationship between two variables (McCall, 1990). In order to further understand the relationships between variables that are continuous in nature, as specified earlier, Pearson's product moment correlation coefficients will be produced. While not deducing causation, these coefficients, which range from -1.00 to +1.00, will indicate the degree of a linear relationship between variables, where an increase in one variable will be associated with a corresponding increase (if a positive relationship) or decrease (if a negative relationship) of the other variable.

Pearson's product moment correlation coefficients will be calculated to establish whether linear relationships exist between the age variable and the computer attitude scales, thereby providing expansion on hypotheses 3 and 4.

6.5.4. t-tests

In order to establish whether a statistical difference exists between the means of two independent sample groups, a t-test is used. Essentially a statistical difference will exist if the variance of one variable differs sufficiently from that of the next one (McCall, 1990). This statistical technique was therefore deemed appropriate for the comparisons attitudes by gender and pre-and post-intervention scores thereby testing hypothesis 2 and to test whether a statistical difference exists between White and Black subjects owing to the nature of this being a South African sample.

6.5.5. Mann-Whitney U Tests

For data that is ordinal in nature, which will be the case for the small sample sizes of the control group, Mann-Whitney tests of independent sample comparisons for non-parametric data will be used. Thus to test whether significant differences between the experimental and control groups exist (hypothesis 4), this method of analyses will be conducted.

6.5.6. ANOVA

ANOVA, or analysis of variance, is a technique used to establish whether there is a statistical difference between the means of more than two independent samples (McCall, 1990). It was therefore used to test hypothesis 1 and 3 for the variables of knowledge/usage and age, as well as to explore possible differences in means of computer attitude scores in terms of marital status, education, and mental models.

When analysis of variance is statistically significant, *Fisher's Least Significant Difference* (LSD) is conducted as a post hoc comparison to ascertain which pair or pairs of means are statistically significant out of the entire set of means. When reading these results, the value in brackets indicates the difference in the means and the value is the significance of the difference.

6.5.7. Cross Tabulations

In order to account for the discrete nature of the data of the categorised variables, contingency tables are required to establish whether any differences exist between these variables. This is utilised, therefore to determine whether there is a statistical difference between the mental models of subjects prior to the computer course and subsequent to it (hypothesis 5), and also to determine whether there is a relationship between computer knowledge and mental models (hypothesis 7) and whether knowledge of other computer-like devices influence mental model construction (hypothesis 6).

When cross tabulation relationships (calculated as χ^2 statistic) are significant, *Correspondence analysis* is conducted to ascertain where the difference between the categories lies. This procedure provides a graphical representation of the relationship between the categories of the table (Greyling and Thatcher, 1997).

CHAPTER 7: RESULTS

7.1. Chapter Summary

The following chapter presents the results of the analyses of the data. The chapter initially presents the preliminary results relating to the reliability coefficients of the questionnaire as well as its factor structure. It then presents the results of the correlations, followed by the t-tests, the ANOVA's and the relevant LSD analyses. The final section of this chapter presents the results of the correspondence analysis.

7.2. Preliminary Results

7.2.1. Reliability results of the CAS

In order to determine whether the present study's results are reliable and in line with previous administrations of the Loyd and Gressard (1984) Computer Attitude Scale, Cronbach's alphas were calculated for the total attitude scale and for each of the sub-scales, for both the experimental and control group's pre- and post-intervention scores and are presented in Table 4 which follows.

Table 4: Cronbach's alphas for Computer Attitude Scale

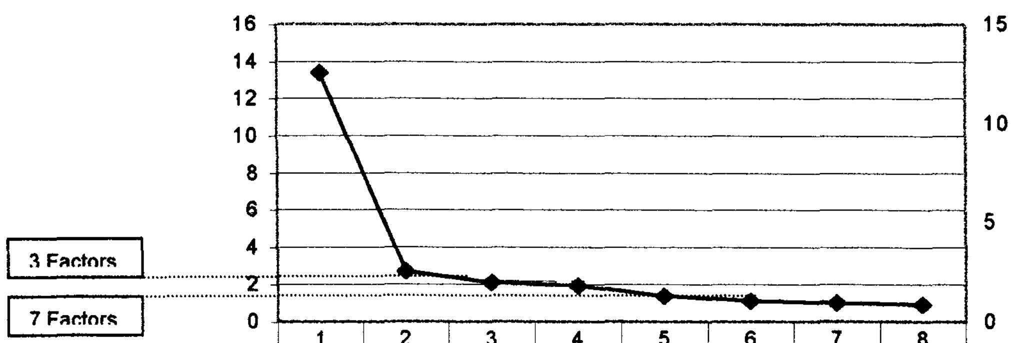
Scale	Cronbach's α
Pre-course total attitude scores	0.95
Pre-course computer anxiety scores	0.90
Pre-course computer confidence scores	0.87
Pre-course total attitude scores	0.87

The reliability analyses were conducted on the pre-intervention sample scores owing to the fact that this was the largest sample. Results of the reliability analyses indicate that the scores that have been found in the present study are reliable, in line with those that have been found with previous studies (as discussed in the previous chapter) and are furthermore also acceptable for the social sciences (Lowenthal, 1996; Rosenthal and Rosnow, 1991). Owing to the fact that most other studies have utilised the scale on high school pupils, students and teachers, the present sample is possibly more diverse in language differences and occupation than that have been examined previously, and therefore these reliability coefficients have a positive reflection on the reliability of the instrument on alternative population groups in general.

7.2.2. Factor Analysis of the CAS

Confirmatory principle component analysis with varimax rotation was conducted on the Computer Anxiety scale, limited to three factors, in order to ascertain whether factor loadings on the present sample were similar to the original sub-scales. The eigenplot of variance explained is shown below in Figure 5. This is then followed by the item factor loadings, when the component analysis is limited to three factors.

Figure 5: Eigenvalue plot of variance explained



	1 Compo	2 Compo	3 Compo	4 Compo	5 Compo	6 Compo	7 Compo	8 Compo
Eigenvalue	13.39	2.697	2.101	1.931	1.37	1.121	1.004	0.914
% Variance Explained	44.632	8.988	7.003	6.438	4.567	3.737	3.347	3.047

Table 5: Factor Loadings of the CAS

ITEM	Factor1	Factor2	Factor3
Computers do not scare me at all (A)	.78		
Working with a computer would make me very nervous (A)		.72	
I do not feel threatened when others talk about computers (A)	.56		
I feel aggressive and hostile towards computers (A)		.72	
It wouldn't bother me at all to take computer courses (A)	.66		
Computers make me feel uncomfortable (A)		.60	
I would feel at ease in a computer class (A)	.73		
I get a sinking feeling when I think of trying to use a computer (A)	.83		
I would feel comfortable working with a computer (A)	.75		
Computers make me feel uneasy and confused (A)	.78		
I'm no good with computers (C)	.67		
Generally, I would feel OK about trying a new problem on the computer (C)		.83	
I don't think I would do advanced computer work (C)		.70	
I am sure I could do work with computers (C)		.52	
I'm not the type to do well with computers (C)	.46		
I am sure I could learn a computer language (C)		.70	
I think using a computer would be very hard for me (C)	.78		
I could get good grades in computer courses (C)	.43	.56	
I do not think I could handle a computer course (C)	.56		
I have a lot of self-confidence when to comes to working with computers (C)	.39	.54	.35
I would like working with computers (L)	.45	.45	.54
The challenge of solving problems with computers does not appeal to me (L)			.76
I think working with computers would be enjoyable and stimulating (L)		.44	.54
Figuring out computer problems does not appeal to me (L)	.46		.63
When there is a problem with a computer that I can't immediately solve, I would stick with it until I have the answer (L)			.64
I don't understand how some people can spend so much time working with computers and seem to enjoy it (L)	.55		.51
Once I start to work with the computer I find it hard to stop (L)			.56
I will do as little work on the computer as possible (L)		.72	
If a problem is left unsolved in a computer case, I would continue to think about it afterward (L)			.83
I do not enjoy talking with others about computers (L)		.65	

NOTE: For ease of reference, the sub-scales have been re-ordered and written in brackets next to the item.

As one can see in Table 5, the factor structure that was revealed is contradictory to the sub-scale break-down of Loyd and Gressard (1984). Three of the computer anxiety items fall under the second factor, four of the confidence items fall under the first factor, while three items from the liking scale fall under either the first or second factor. This may be considered an adequate factor structure for a small sample of data (N=62). Figure 5 graphs the variance explained according to the factor analysis. As one can see, three factors explain a total 60% of the variance, while at the same time, only one factor explains 44%. The factor analysis, using Kaiser's criterion (not shown in results) extracts seven factors, which explains a total of 78.7% of the variance (read off data table of Figure 5). Further discussion follows in Section 8.2.1.

7.3. Cluster Analyses

The cluster analyses procedures resulted in six clusters for the knowledge/usage and mental models variables respectively. For ease of review, frequency distributions, according to these clusters are presented below. Examples of drawings in each of the mental models categories can be found in Appendix C.

Table 6: Frequency distributions of mental models clusters prior to course

	Mental models	**N**
1.	No conceptual idea	18
2.	Drawn a simple diagram of an electronic device	6
3.	Drawn a simple computer but labelled it with electronic jargon or computer functionality and no direct association with internal features	17
4.	Drawn a computer box, very simple and included only one or two features	11
5.	Drawn a computer box, but missing some essential elements for operation, only three or four features	7
6.	Drawn what is inside a computer box, fairly comprehensive, included five or six features	3

Table 7: Frequency distributions of mental models clusters after the course

	Mental models	N
1.	No conceptual idea	2
2.	Drawn a simple diagram of an electronic device	4
3.	Drawn a simple computer but labelled it with electronic jargon or computer functionality and no direct association with internal features	5
4.	Drawn a computer box, very simple and included only one or two features	12
5.	Drawn a computer box, but missing some essential elements for operation, only three or four features	4
6.	Drawn what is inside a computer box, fairly comprehensive, included five or six features	5

Table 8: Frequency distributions of knowledge/usage clusters prior to the course

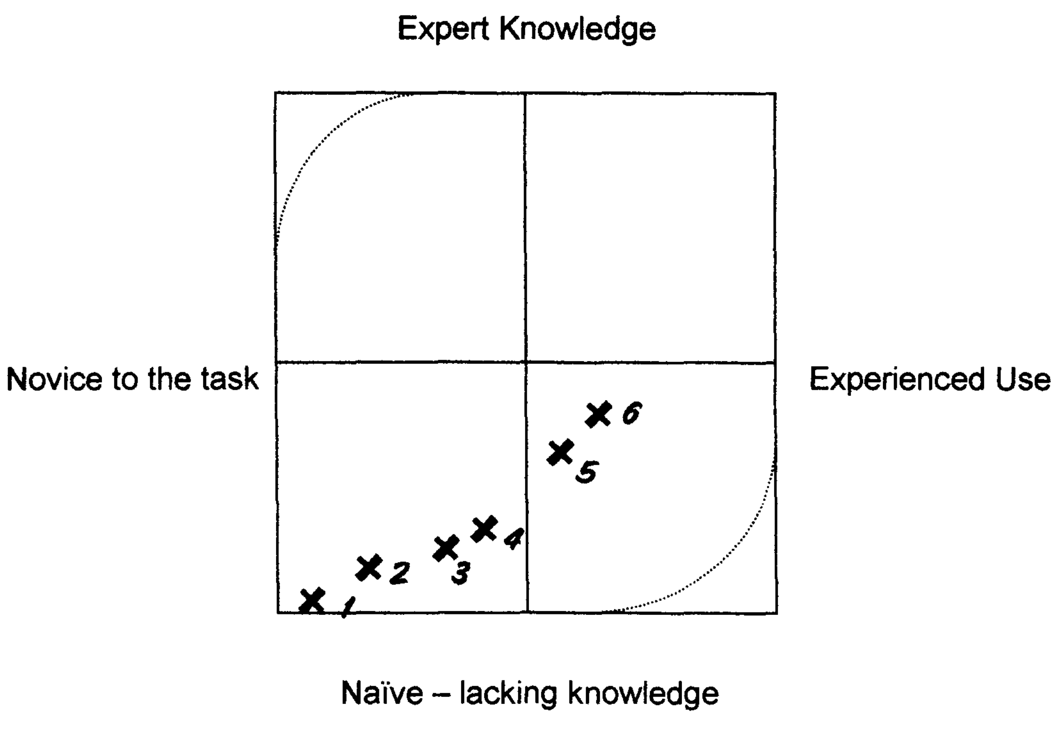
	Previous Knowledge / Usage of computers	N
1.	Seen others use a computer, never used one themselves	8
2.	Seen others use a computer, tried to use for self but in a very limited way	5
3.	Used before in a basics course	2
4.	Used before but neither practised nor felt confident	14
5.	Used often but new to the program/application of the course	17
6.	Used very often for a variety of applications	3

The features that were delineated as possible elements to the mental models drawings were memory, CPU, power, motherboard and/or cards, stiffy and/or CD Rom drives and Ribbons and/or wires.

The frequency distributions of the mental models categories are mainly greater than five in each category, which is considered an acceptable reflection of the sample. Furthermore, when there was a frequency of less than five in a category, analyses were conducted both including that category and excluding it, thereby establishing the influence of the existence of the category on the significance of the results. Additionally, the first category of the mental models research incorporated both those who chose not to answer the mental models drawing section of the questionnaire as well as those who simply stated in this question that they had no idea or were attending the class in order to learn. As a result, cross tabulations, and resulting correspondence analyses where applicable, were run on the basis of including this category and without. However, owing to the fact that most people had some sort of mental model at the end of the course, this category did not feature on the correspondence analysis graph, in either case and was therefore excluded in the analysis for better validity (see Figure 5 in section 7.6.1.).

For interest and without conducting any statistical analyses, the researcher plotted the various knowledge/usage categories shown below in Figure 6.

Figure 6: Two-dimensional conceptual space for user knowledge and experience for the present research's sample, prior to the computer course



7.3. Pearson's Product Moment correlation coefficients

In order to begin to understand the relationships between the variables that were measured, Pearson's product moment coefficients were calculated. These results are presented in Table 9 below.

Table 9: Correlations of age and attitude scores

	Pre-CompAnx	Pre-ComConf	Pre-CompLike	Pre-Computer AttTotal
Age	-0.218	-0.426**	-0.156	-0.300*
Post-CompAnx	0.712**	0.718**	0.599**	0.752**
Post-ComConf	0.665**	0.784**	0.663**	0.777**
Post-CompLike	0.536**	0.567**	0.822**	0.689**
Post-Att. total	0.752**	0.809**	0.805**	0.866**
Pre- CompAnx	-	0.763**	0.664**	0.908**
Pre- ComConf	-	-	0.742**	0.926**
Pre- CompLike	-	-	-	0.874**

* p< 0.05 ** p<0.01

These results reveal that there is a significant correlation with the age variable (uncategorised) and computer confidence (p<0.01) and computer attitudes in general (p<0.05).

Importantly, the reader's attention is drawn to the highly significant correlations between the measures of computer attitude scales (all p<0.01) in terms of both prior to the course when compared to afterwards, as well as between the measures themselves. This would then indicate a high test-retest correlation between the measures themselves.

7.4. T-tests

T-Tests were conducted with respect to the possible influence of gender on attitudes, home language on attitudes and to compare attitude scores from before and after the computer course as well as to the control group,. Results of these analyses are presented in Table 10, 11, and 12 below.

7.4.1. Gender and attitudes

Table 10: T-tests generated for computer attitude score comparisons by gender

Independent Variable	Dependent Variable	Mean Males	Males N	Mean Females	Females N	t	df	Sig.
Gender	CompAnx	30.26	20	31.05	42	-0.266	60	0.791
	CompConf	32.45	20	30.75	42	-0.727	60	0.470
	CompLiking	30.89	20	31.12	42	0.434	60	0.666
	CompAtt total	94.10	20	93.48	42	-0.236	60	0.814

The above findings affirm that there is no significant differences between the means of males and female respondents' computer anxiety, confidence, liking and overall attitude to computers scores. Thus hypothesis 2 is rejected.

7.4.2. Home Language

In order to analyse differences between Black and White subjects, the home language variable had to be re-coded differentiating therefore only between two categories. English, Afrikaans and Italian comprising the one and Zulu, South Sotho, North Sotho, Venda, Tswana and Xhosa comprising the other.

Table 11: T-tests generated for computer attitude score comparisons by home language

Independent Variable	Dependent Variable	N White	Mean White	N Black	Mean Black	t	df	Sig.
Home Language	Pre-CompAnx	39	33.26	21	29.50	-2.712	59	0.009**
	Pre-CompConf	39	36.29	21	31.15	-4.314	59	0.000**
	Pre-CompLiking	39	30.66	21	27.60	-2.715	59	0.009**
	Pre-CompAtt total	39	100.21	21	88.25	-3.631	59	0.001**
	Post-CompAnx	17	33.171	14	32.67	0.476	30	0.638
	Post-CompConf	17	33.31	14	30.83	-1.733	30	0.096
	Post-CompLiking	17	31.31	14	29.42	-1.317	30	0.201
	Post-CompAtt total	17	96.93	14	93.42	-0.865	30	0.396

* $p< 0.05$ ** $p<0.01$

These results show that there is a significant difference in all attitude scores between Blacks and Whites ($p<0.01$ in all instances). Moreover, these differences no longer exist subsequent to the computer course.

Thus there are differences in attitudes prior to the computer course, but subsequent to the course, all subjects had statistically the same attitudes. Thus it can be said that the controlled exposure to computers eliminates any differences in attitudes that may exist as a result of variances in languages spoken at home.

7.4.3. Pre- and Post-intervention attitude comparisons

Table 12: Matched pairs t-test for pre- and post-computer attitude comparisons

Pre- Attitudes	Mean	Post Attitudes	Mean	t	df	Sig.
Pre-CompAnx	32.72	Post-CompAnx	33.30	0.822	32	0.419
Pre-CompConf	32.12	Post-CompConf	35.20	5.564	32	0.000**
Pre-CompLiking	30.40	Post-CompLiking	30.64	0.559	32	0.581
Pre-CompAtt total	95.24	Post-CompAtt total	99.14	3.344	32	0.003**

Hypothesis 4 stated that there would be differences in computer attitudes subsequent to the computer course. This hypothesis is partly supported in the fact that overall attitudes towards computers have significantly changed ($p=0.003$), together with computer confidence ($p=0.000$). Thus the computer course influences the attitudes of the respondents in the effect that they have a better overall attitude toward computers.

7.5. Mann-Whitney U tests

In order to establish the stability of the control group in comparison to the experimental groups, Mann-Whitney tests were conducted on the data owing to the fact that the control group consisted of a small number of subjects ($N=11$).

Table 13: Mann-Whitney U tests for experimental versus control group attitudes

Independent Variable	Dependent Variable	*U*	Sig.
Group	Pre-CompAnx	307.50	0.604
	Pre-CompConf	202.50	0.032*
	Pre-CompLiking	328.50	0.846
	Pre-CompAtt total	253.00	0.175
	Post-CompAnx	116.00	0.458
	Post-CompConf	85.50	0.072
	Post-CompLiking	106.50	0.285
	Post-CompAtt total	87.50	0.086

* p< 0.05 ** p<0.01

According to hypothesis 4, the control group should have been statistically the same as the pre-test attitude scores and these should have been statistically different to the post-test attitude scores. Instead, the confidence scores between the pre-test measures for the control and experimental groups differed in terms of confidence. Additionally, no differences were found when attitudes subsequent to the computer course were compared to the control groups measures over a similar time period. The discussion chapter will further address the issues of the computer attitude scale in more detail (section 8.2.1.) as well as discuss the relevant conclusions that can be drawn from these analyses (sections 8.3.3 and 8.3.4.).

7.6. ANOVA

Analysis of variance was conducted on the variables of computer knowledge/usage, home language, occupation and age. As part of the further analyses, ANOVA's were conducted on variables of education, marital status and mental models against attitudes, however, owing to the fact that these did not result in significant differences they are not presented. Where appropriate, LSD effects are presented when the ANOVA statistic is significant. For each LSD effect, the differences in the means are presented first in brackets, followed by the p values.

7.6.1. Knowledge/usage variable and attitudes

Table 14: ANOVA for computer knowledge/usage variable and attitudes

	N	Mean	df	F	Sig.
Pre-CompAnx	49	30.255	5 43	3.078	0.018*
Pre-CompConf	49	32.408	5 43	2.429	0.050*
Pre-CompLiking	49	28.265	5 43	3.409	0.011*
Pre-CompAtt total	49	90.929	5 43	3.524	0.009**
Post -CompAnx	31	32.833	5 25	1.538	0.228
Post -CompConf	31	32.208	5 25	1.362	0.284
Post -CompLiking	31	30.417	5 25	1.612	0.208
Post-CompAtt total	31	95.458	5 25	1.719	0.181

* $p< 0.05$ ** $p<0.01$

Table 15: LSD for Pre-course Computer attitudes

MAIN EFFECT – KNOWLEDGE/USAGE OF COMPUTERS

ATTITUDE	Computer Know/Usage	2	3	4	5	6 (often)
Computer Anxiety	(1) Seen others, never used for self	(0.28)+ 0.927	(-4.13) 0.322	(-1.98) 0.395	(-6.04) **0.010****	(-9.46) **0.010****
	(2) Seen others, used for self, limitedly	-	(-4.40) 0.318	(-2.26) 0.410	(-6.31) **0.022***	(-9.73) **0.014***
	(3) Used before in basics course	-	-	(2.14) 0.589	(-1.91) 0.626	(-5.33) 0.268
	(4) Used but never practised/confident	-	-	-	(-4.05) **0.037***	(-7.48) **0.029***
	(5) Used often, new to program/application	-	-	-	-	(-3.42) 0.300
Computer Confidence	(1) Seen others, never used for self	(-0.33) 0.907	(-3.63) 0.348	(-3.98) 0.07	(-4.71) **0.028***	(-9.46) **0.006****
	(2) Seen others, used for self, limitedly	-	(-3.30) 0.419	(-3.66) 0.153	(-4.39) 0.081	(-9.13) **0.013***
	(3) Used before in basics course	-	-	(-0.36) 0.923	(-1.09) 0.765	(-5.83) 0.193
	(4) Used but never practised/confident	-	-	-	(-0.73) 0.677	(-5.48) 0.082
	(5) Used often, new to program/application	-	-	-	-	(-4.75) 0.124
Computer Liking	(1) Seen others, never used for self	(2.25) 0.351	(-2.25) 0.500	(-1.18) 0.529	(-3.81) **0.040***	(-8.08) **0.007****
	(2) Seen others, used for self, limitedly	-	(-4.50) 0.206	(-3.43) 0.123	(-6.06) **0.007****	(-10.33) **0.002****
	(3) Used before in basics course	-	-	(1.07) 0.736	(-1.56) 0.621	(-5.83) 0.134
	(4) Used but never practised/confident	-	-	-	(-2.63) 0.089	(-6.91) **0.013***
	(5) Used often, new to program/application	-	-	-	-	(-4.27) 0.110
Computer Attitude Total	(1) Seen others, never used for self	(2.20) 0.762	(-10.00) 0.323	(-7.14) 0.210	(-14.56) **0.010****	(-27.00) **0.003****
	(2) Seen others, used for self, limitedly	-	(-12.20) 0.256	(-9.34) 0.164	(-16.76) **0.013***	(-29.20) **0.003****
	(3) Used before in basics course	-	-	(2.86) 0.767	(-4.56) 0.632	(-17.00) 0.148
	(4) Used but never practised/confident	-	-	-	(-7.42) 0.112	(-19.86) **0.018***
	(5) Used often, new to program/application	-	-	-	-	(-12.44) 0.124

* $p < 0.05$ ** $p < 0.01$ + The value in brackets depicts the difference in means

Table 14 reveals that attitudes differ significantly according to prior knowledge in terms of anxiety (p=0.018), confidence (p=0.05) and liking (p=0.011) as well as overall attitudes (p=0.009), however, this no longer exists subsequent to the course owing to the fact that all p values are greater than 0.05. Thus the computer course 'levels the playing fields' as such, in terms of computer attitudes. The LSD results reveal that the main differences in attitudes lie in those who have never sat down at the computer before as opposed to those who use it in their daily lives at work or at home or both. These can be seen in Table 15, where the attitude sub-scale scores of those who used the computer often, either for a specific function (computer knowledge/use category 5) or a variety of functions (category 6) were greater than those who had either never used the computer before or used only in a very limited way (categories 1 and 2). In terms of overall attitude towards computers attitudes were more negative for those who had seen others use a computer but had never used one themselves and those who had either used the computer for a specific function (p=0.010) or those who had used computers before for a variety of functions (p=0.003). These results were also similar for those who had only used a computer in a limited way and the above two other categories with p values of 0.013 and 0.003, respectively. Additionally if the person had used computer before but had never practised or felt confident, their attitude scores were more negative than those who had used the computer often (p=0.018)

7.6.2. Age and attitudes

Table 16: ANOVA for age variable and attitudes

	N	Mean	df	F	Sig.
Pre-CompAnx	61	30.795	6 54	1.305	0.267
Pre-CompConf	61	32.918	6 54	3.232	0.006**
Pre-CompLiking	61	28.656	6 54	1.365	0.240
Pre-CompAtt total	61	92.369	6 54	2.045	0.067
Post-CompAnx	31	32.720	5 25	0.403	0.841
Post -CompConf	31	32.120	5 25	2.111	0.108
Post -CompLiking	31	30.400	5 25	0.575	0.718
Post-CompAtt total	31	95.240	5 25	0.710	0.623

* p< 0.05 ** p<0.01

Table 17: LSD test for computer confidence

MAIN EFFECT: AGE

AGE	21-30 (2)	31-40 (3)	41-50 (4)	51-60 (5)	≥61 (6)
(1) 20 yrs or less	(-5.67)+ 0.095	(-5.05) 0.125	(0.27) 0.936	(0.33) 0.923	(-1.00) 0.785
(2) 21 yrs – 30 yrs	-	(0.62) 0.700	(5.94) **0.002****	(6.00) **0.003****	(4.67) **0.050***
(3) 31 yrs – 40 yrs	-	-	(5.32) **0.002****	(5.38) **0.003****	(4.05) 0.069
(4) 41 yrs – 50 yrs	-	-	-	(0.01) 0.975	(-1.27) 0.591
(5) 51 yrs – 60 yrs	-	-	-	-	(-1.33) 0.586

* p< 0.05 ** p<0.01 + The value in brackets depicts the difference in means

Table 16 reveals that there is a significant main effect (p=0.006) for computer confidence in terms of age, before the computer course. The LSD analyses for confidence, shown in Table 17, reveal that the significant differences exist for those who are between the ages of 21 and 30 and those who are above the age of 40, in other words the younger age group have greater confidence than their elders who are above the age of 40. However, these differences were not significant subsequent to the course. No other differences in attitudes were found for age and thus hypothesis 3 is only partially supported. Further discussion can be found in the ensuing chapter.

7.6.3. Occupation and attitudes

Table 18: ANOVA for occupation variable and attitudes

	N	Mean	df	F	Sig.
Pre-CompAnx	57	30.714	5 51	2.42	0.048*
Pre-CompConf	57	31.588	5 51	6.02	0.000**
Pre-CompLiking	57	28.875	5 51	3.12	0.016*
Pre-CompAtt total	57	91.180	5 51	4.21	0.003**
Post-CompAnx	31	32.544	5 25	1.40	0.254
Post -CompConf	31	32.375	5 25	1.36	0.284
Post -CompLiking	31	30.333	5 25	1.61	0.210
Post-CompAtt total	31	95.255	5 25	1.78	0.180

* p< 0.05 ** p<0.01

Table 19: LSD for Pre-course Computer attitudes
MAIN EFFECT – OCCUPATION

ATTITUDE	Occupation	2	3	4	5	6 (profess)
Computer Anxiety	(1) Not working	(1.00) + 0.815	(-6.37) **0.012***	(-5.79) **0.027***	(-2.00) 0.480	(-3.38) 0.236
	(2) Student	-	(-7.37) 0.063	(-6.79) 0.091	(-3.00) 0.469	(-4.38) 0.293
	(3) Entry level position	-	-	(0.58) 0.752	(4.37) 0.052	(2.99) 0.179
	(4) Middle Management	-	-	-	(3.79) 0.107	(2.41) 0.301
	(5) Senior Management	-	-	-	-	(-1.38) 0.600
Computer Confidence	(1) Not working	(-0.67) 0.849	(-8.11) **0.000****	(-7.24) **0.001****	(-2.42) 0.299	(-2.42) 0.299
	(2) Student	-	(-7.45) **0.023***	(-6.57) **0.047***	(-1.75) 0.606	(-1.75) 0.606
	(3) Entry level position	-	-	(0.88) 0.562	(5.70) **0.003****	(5.70) **0.003****
	(4) Middle Management	-	-	-	(4.82) **0.014***	(4.82) **0.014***
	(5) Senior Management	-	-	-	-	(0.00) 1.00
Computer Liking	(1) Not working	(7.00) **0.044***	(-2.66) 0.178	(-3.00) 0.145	(0.13) 0.956	(0.63) 0.782
	(2) Student	-	(-9.66) **0.003****	(-10.00) **0.002****	(-6.88) **0.041***	(-6.38) 0.058
	(3) Entry level position	-	-	(-0.34) 0.816	(2.78) 0.118	(3.28) 0.067
	(4) Middle Management	-	-	-	(3.13) 0.096	(3.63) 0.054
	(5) Senior Management	-	-	-	-	(0.50) 0.811
Computer Attitude Total	(1) Not working	(7.33) 0.462	(-17.14) **0.004****	(-16.02) **0.009****	(-4.29) 0.515	(-5.17) 0.434
	(2) Student	-	(-24.47) **0.009****	(-23.36) **0.014***	(-11.62) 0.231	(-12.50) 0.198
	(3) Entry level position	-	-	(1.12) 0.795	(12.85) **0.015***	(11.97) **0.023***
	(4) Middle Management	-	-	-	(11.73) **0.034***	(10.86) **0.049***
	(5) Senior Management	-	-	-	-	(-0.88) 0.886

* $p < 0.05$ ** $p<0.01$ + The value in brackets depicts the difference in means

Table 18 of the ANOVA results reveals that significant differences exist for all attitude scores according to occupation, although these differences no longer exist subsequent to the computer course. The LSD results shown in Table 19 show that students show less confidence and liking of computers and have a more negative attitude towards computers than most other occupation groups, on most attitude variables, except anxiety. Additionally those that are not working (i.e. home executives and those who are retired), have greater anxiety, less confidence, and overall more negative attitude than those in entry level positions and middle management. Those in entry level positions have more confidence that those in senior management and professionals (p=0.003 for both) and middle management have greater confidence than those in senior management and professionals (p=0.014 for both). Most occupational levels differ from one another significantly on overall attitudes towards computers, except when those who are not working and students are compared to senior management and professionals.

In order to ascertain whether occupation was related to age and education, chi-squared analyses were conducted, both producing significant results:
χ^2 for occupation and age has a value of 46.374 (p= 0.029, df= 30).
And χ^2 for occupation and education has a value of 35.025 (p= 0.002, df= 15).

7.7. Cross-tabulations

As delineated in the methodology section, cross-tabulations were used to further understand differences in categorical data that were produced in the research. Hypothesised analyses and significant findings are presented below. However, it is pertinent to note that gender, home language, occupation, education and martial status did not produce significant results.

7.7.1. Mental Model category comparisons

In order to test hypothesis 5, a cross tabulation for mental model categories from before and after the computer course, was performed. These results are presented in the table below. Appendix D shows some of the drawings that were compared.

Table 20: Cross-tabulation for Pre-Mental Models with Post-Mental Models

Pre Mental Models	Post Mental Models						Total
	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5	Categ. 6	
Categ. 1	2			2			4
Categ. 2		3	3				6
Categ. 3			1	8			9
Categ. 4			1	2	4	1	8
Categ. 5						1	1
Categ. 6						3	3
Total	2	3	5	12	4	5	31

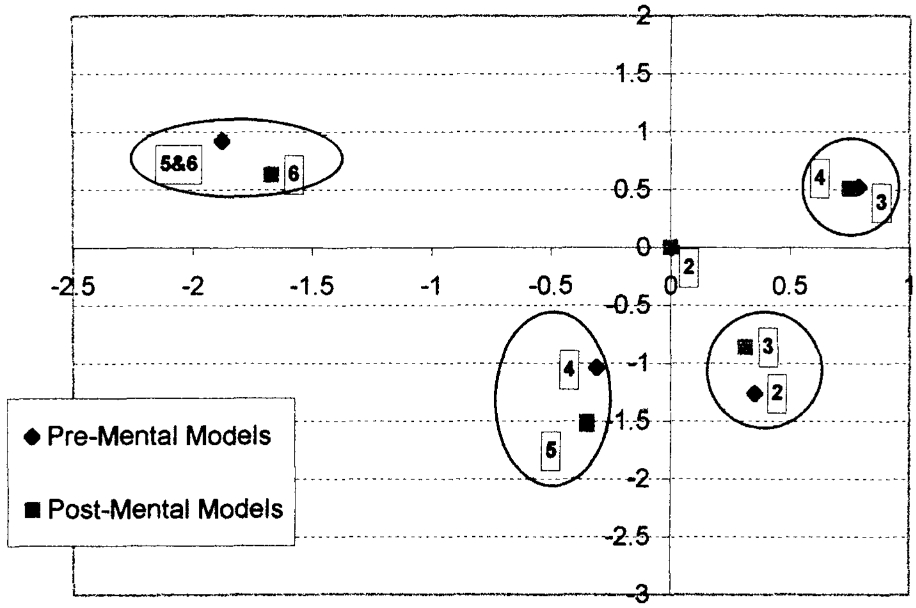
Table 21: Chi-Square Tests for Pre-Mental models and Post-Mental Model

	χ^2 Value	**Df**	**Sig.**
Pearson Chi-Square	29.00	20	0.024*

p<0.05

As a result of a significant χ^2 value ($p<0.05$), correspondence analyses were conducted to determine exactly where the differences lie. These results are shown graphically in Figure 7 below.

Figure 7: Correspondence Analysis of Pre- and Post-Mental Models



The Chi-square statistic leads the researcher to accept hypothesis 5, that the mental model conceptualisations will change as a result of the computer course.

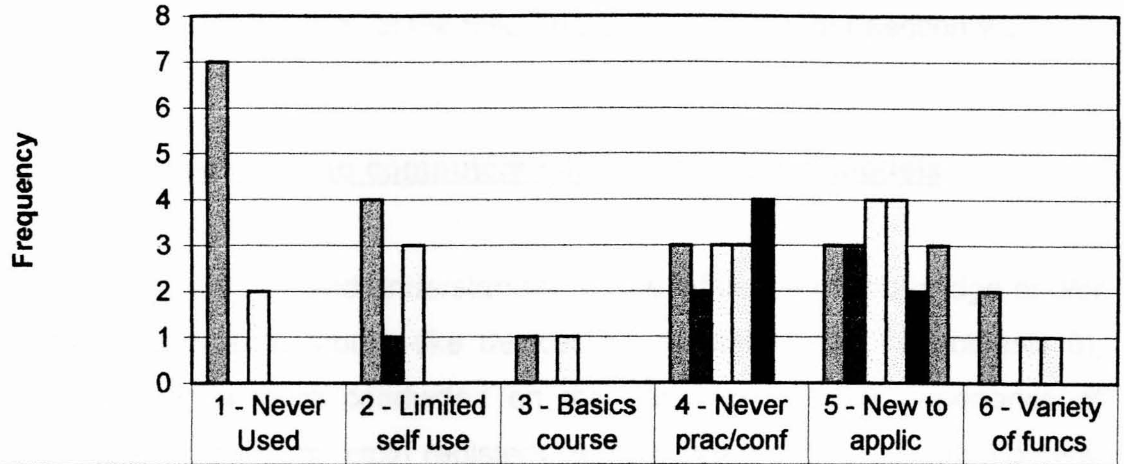
From Figure 7 it can be seen that there were specific changes in mental model conceptualisations, in most of the categories. Starting with the bottom right quadrant, it can be seen that the Pre-Mental model conceptualisations changes from category two to category three. More specifically, they changed from drawing a simple electronic device to drawing a computer and labelling it with electronic jargon or computer functionality and no direct association with internal features. Thus the respondent has specifically changed their conceptualisation, while not dramatically, to applying the electronic jargon to the computer itself. In the top right hand quadrant, it can be seen that the respondents who initially conceptualised the computer in terms on functionality, what it could do, and in terms of electronic jargon (category 3), began to conceptualise the internal features after the computer course (category 4).

It can also be seen in the bottom left hand quadrant, that the if the respondent's conceptualisations were quite basic in terms of features initially, they improved in complexity by the fact that they changed from category 4 to category 5. Furthermore, the category 5's on the initial sample changed to a 6 subsequent to the course, as seen in the top left hand quadrant. Those who included all the features of the computer before their course, re-drew an as complex diagram as before. As was stated in the cluster analysis section (7.2.), owing to the fact that very few people did not have a mental model conceptualisation of the computer subsequent to the course, this category did not feature on the correspondence analysis (believed to be with the post-mental model category two at position 0;0).

7.7.2. Computer Knowledge/Usage influencing Mental Models

In order to further understand the cross-tabulation of the knowledge/usage variable and its relationship with mental models prior to the computer course, the table is presented below, along with a graphical representation frequency distribution of the categories.

Table 22: Cross tabulation of knowledge/usage and mental models prior to computer course



	1 - Never Used	2 - Limited self use	3 - Basics course	4 - Never prac/conf	5 - New to applic	6 - Variety of funcs
1 - No idea	7	4	1	3	3	2
2 - Elec Dev		1		2	3	
3 - Comp func	2	3	1	3	4	1
4 - 1-2 features				3	4	1
5 - 3-4 features				4	2	
6 - 5-6 features					3	

Computer Knowledge

Table 23: Chi-Square Tests for Computer Knowledge/Usage and Mental Models

	χ^2 Value	Df	Sig.
Pearson Chi-Square	28.23	25	0.29

As one can see from the above χ^2 statistic, the computer knowledge rating and mental models are not significantly related. In other words, mental model conceptualisations do not vary according to knowledge or prior usage of computers. However, this result measures a relationship between categories. The knowledge/usage categories are not necessarily hierarchical; a category of 4 where the person has used a computer before but never felt confident could possibly relate to them not being able to conceptualise how it functions (a mental model of 1 or 3). Reading off Table 22, it can be seen that those who had no idea what was under the lid of the computer box ranged across the knowledge/usage categories. Further discussion of this issue can be found under section 8.4.1. of the following chapter and under section 9.2.

7.7.3. Prior exposure to computers influencing mental models

In order to further expand understanding of the influence of knowledge and/or exposure to other computer-like devices on mental models (hypothesis 6), cross-tabulations were conducted on the variables of prior experience of typewriters, calculators, cash registers, ATM's, video games and computers. Only the respondent's prior exposure to computers revealed a significant result. This therefore lends one to reject hypothesis 6 which detailed that interaction with other computer like devices would influence the respondent's mental model of the computer. Details are shown in Table 24 and 25 below.

Table 24: Cross-tabulation for Pre-Mental Models and Prior exposure to computers

Prior Exposure to comp's	Pre Mental Models						Total
	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5	Categ. 6	
Seen	6		3				9
Used	6	3	9	3	4		25
Owned	6	3	1	6	3	3	22
Total	18	6	13	9	7	3	56

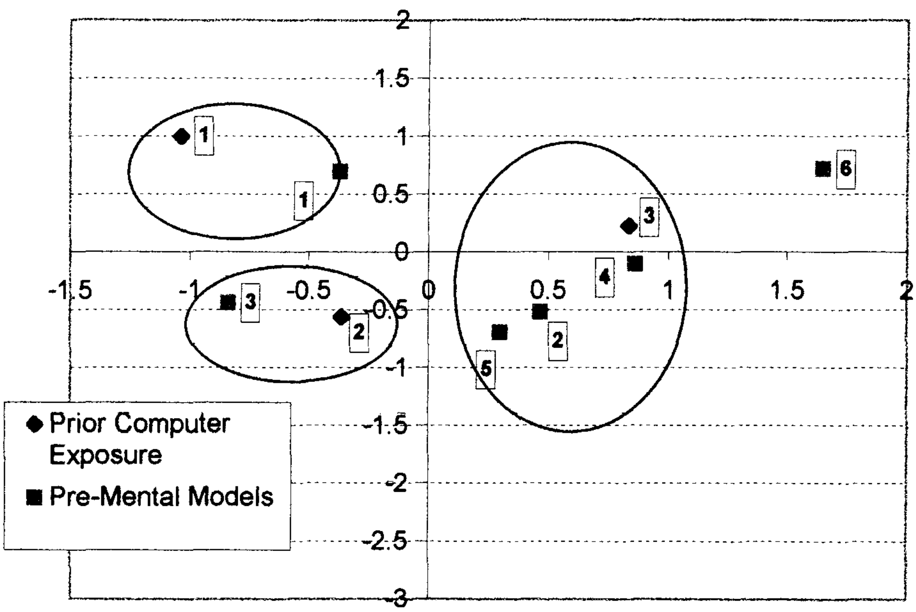
Table 25: Chi-Square Tests for Pre-Mental Models and prior exposure to computers

	χ^2 Value	Df	Sig.
Pearson Chi-Square	20.11	10	0.028*

* p<0.05

As a result of the significance of the Chi-squared statistic, correspondence analysis was conducted to further understand the relationships between the variables.

Figure 8: Correspondence Analysis of Pre-Mental Models and prior exposure to computers



It can be seen from these results that if a person has only seen the computer, they do not have a conceptualisation of the computer (top left hand quadrant). However, having actually used a computer (bottom left), further aids the user's conceptualisation of the computer – they label it with electronic jargon and computer functionality. Furthermore, once a person owns a computer, their conceptualisation of the computer relates directly to the internal parts of the computer (either with electronic components or with between one and four actual computer features).

Table 26 shows the distribution of the prior exposure to computers variable and mental models subsequent to the computer course.

Table 26: Cross-tabulation for Post-Mental Models and Prior exposure to computers

Prior Exposure to comp's	Post Mental Models						Total
	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5	Categ. 6	
Seen		2	1	3			6
Used	1		4	6	2		13
Owned	1			2		4	7
Total	2	2	5	11	2	4	26

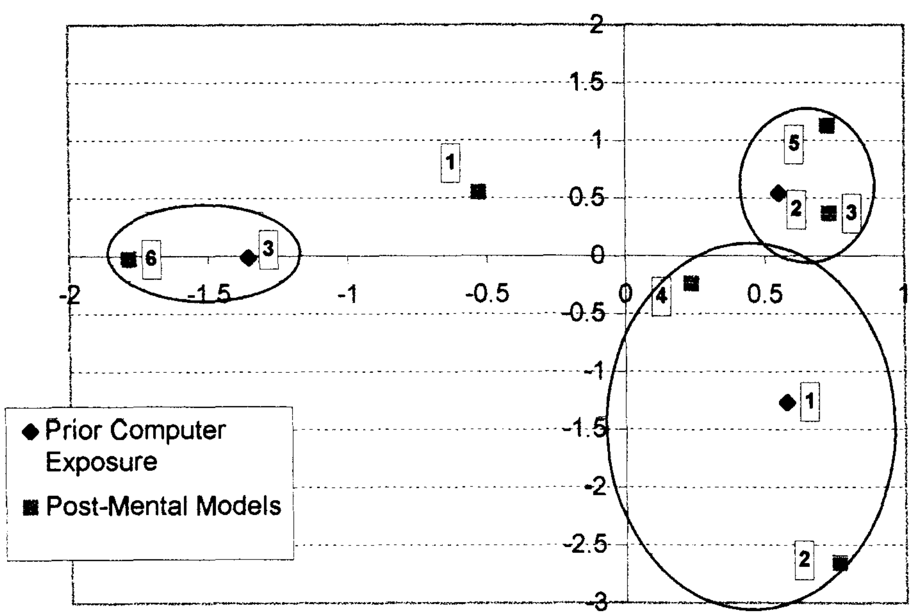
Table 27: Chi-Square Tests for Post-Mental Models Prior Exposure to computers

	χ^2 Value	df	Sig.
Pearson Chi-Square	19.28	10	0.037*

* $p<0.05$

Figure 8 below shows the significant relationship between prior exposure to computers and the mental models of users *subsequent* to the computer course (χ^2 =19.28; p=0.037)

Figure 9: Correspondence Analysis of Post-Mental Models and prior exposure to computers



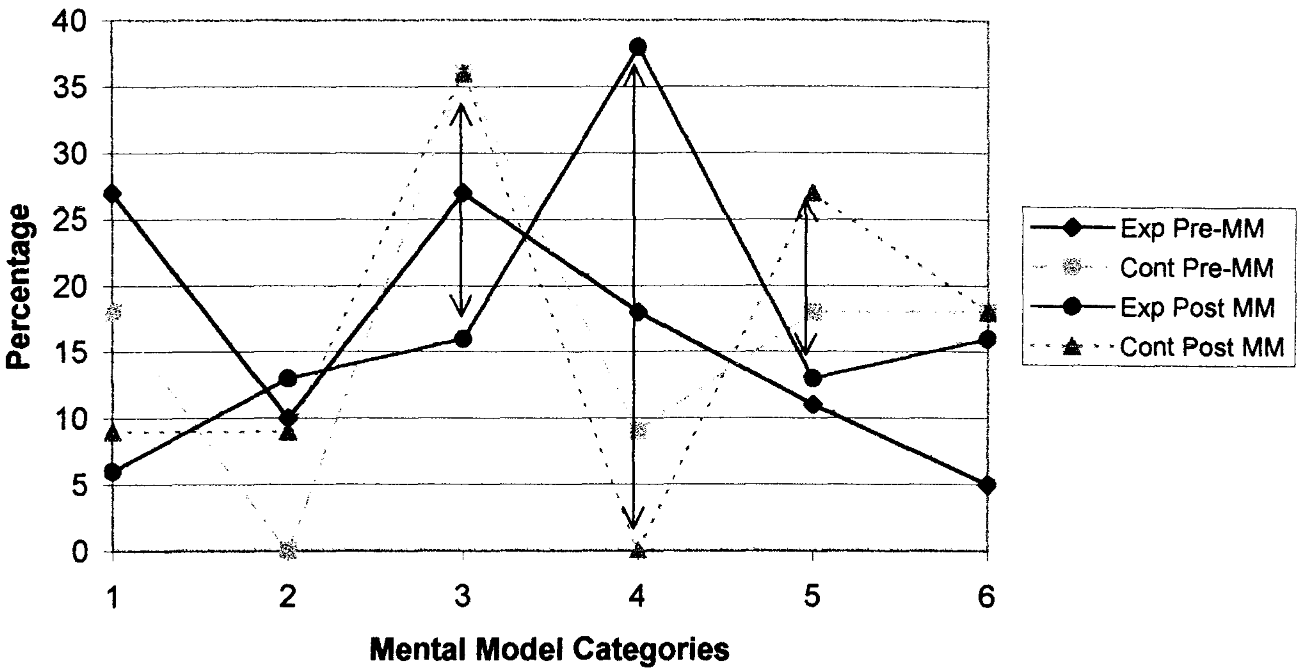
It can be seen from this diagram that, again, differences between having seen, used or owned a computer influence mental model conceptualisations. After the computer course, having used a computer now relates to the user conceptualising the computer in terms of computer jargon or alternatively, actual internal features of the computer (top right quadrant). Additionally, those who had never used the computer before, have now perceived it to be similar to other electronic equipment or alternatively to change conceptualisations to that of the basic internal features of the computer (bottom right quadrant). Those who owned the computer again had a more complex understanding of the computer (top right quadrant). These results therefore lend partial support for hypothesis 7.

Having now found both a difference in the mental models of the users before and after the computer course, and having found that prior interaction with the computer influences this, it now becomes pertinent to understand how the mental models of the control group differed over a similar time span.

7.7.4. Mental Models of Experimental group compared to Controls'

Owing to the fact that the control group sample size was so small thereby eliminating correspondence analyses, the comparison between mental models of the experimental group and those of the controls' are shown graphically.

Figure 10: Experimental group mental models compared to controls'



These results indicate that although the sample size of the control is relatively small, it has a similar distribution to that of the experimental groups' pre-intervention measures. Additionally, while the control group stayed relatively stable over time, the changes in the post-intervention measures clearly deviate from the controls'. These results therefore mean that the intervention of the computer course was indeed the reason why the mental models changed as opposed to the testing environment itself.

CHAPTER 8: DISCUSSION

8.1. Chapter Introduction and Summary

The need to understand first time adult computer users' attitudes and conceptualisations is ever more important with the proliferation of computers in the modern workplace. Furthermore, the influence of training on these variables has been argued to be of immense importance for organisations, users and trainers alike. The research that was conducted aimed to research the areas of mental models and computer attitudes of users attending a Basic Skills in Computing course, in order to contribute understanding to these concepts using a sound research design.

While the previous chapter presented the results of this research, it is the aim of this chapter to elaborate on the impact of these results on understanding as well as to link them in with previous research that was elaborated in the literature review section.

The chapter is presented in terms of the two major variables that were studied, that being those of computer attitudes and mental models. First, however the preliminary results regarding the attitude scale are discussed. For ease of reading, the results are presented in terms of the hypotheses that were elaborated in Section 5.7, page 37); each variable that was studied is discussed in terms of the influence of knowledge and usage on that variable, the influence of demographics on that variable, the change in that variable as a result of the course and then finally the stability of the control group.

8.2. The attitude scale

As stated earlier in section 6.4.2, the repeatedly reported good reliability coefficients of the Computer Attitude Scale was one of the underlying reasons why this scale was utilised in the present study. Again, the instrument reported excellent reliability ratings (Cronbach's α for total attitude scale 0.95 in Table 4, section 7.2.1.). However, the factor structure for the sub-scales in the present study (Table 5, section 7.2.2.) was not consistent with the factor structure on which the break-down of the sub-scales was based (Loyd and Loyd, 1985). The scales' original factor loadings were also not replicated by Fuller (1997) in her South African study of banking employees; she found that while the computer anxiety scale was a significantly discrete factor, the computer liking and confidence factors were not. Woodrow (1991) also found the factor structure to be inaccurate and concluded that this was due to the high correlations between the sub-scales. Furthermore, she also concluded that as an overall score, the CAS total was a good measure of computer attitudes and correlated well with other computer attitude scales, however she recommended that the scale should be presented as two scales rather than three although she also recognised that her conclusions were based on a limited sample size (N=98). These conclusions were founded on the argument that anxiety and confidence are opposites of the same construct and it was as a result of the scales insensitivity to the semantic differences between these two constructs that these two sub-scales loaded heavily towards the first factor, which she called Computer Anxiety.

The present study's factor analyses seem to find similar results to that of Woodrow (1991). While sixty percent of the variance is explained (Figure 5, section 7.2.2), the factor loadings between computer anxiety and confidence found in Table 5 appear to be linked with the *wording* of the items of each sub-scale. In other words when the anxiety sub-scale is positively worded (no anxiety), the loadings tend towards confidence items, thus indicating that the scale cannot differentiate between these two constructs substantially. It is also important to note that in some of these instances, it is the reversed scored item that falls under the second factor, indicating that the respondents were answering according to a response set, exactly what reverse scored items aim to eliminate (Rosenthal and Rosnow, 1991).

Additionally, the variance explained by three factors is extremely high (Figure 5, section 7.2.2). One factor explains 44.6% of the variances, thereby making a three factor structure debatable. This also supports the argument that scale could be measuring a general attitude towards computers, rather than separate anxiety, confidence and liking.

Other than the scale itself, several other plausible reasons why the factor structure has not remained stable need to be discussed. Firstly, the diverse demographic characteristics of the sample may lead the sub-scales to be interpreted differently in comparison to more homogenous samples who have been administered the instrument in the past (such as Loyd and Gressard, 1984; Loyd and Loyd, 1985; Koohang, 1989; Dukes, Discenza, and Cougar, 1989; Woodrow, 1991; Dyck and Smither, 1994 and Busch, 1995). Woodrow proposed that the reason why the factor structure in her study was not consistent was because the scale could not differentiate the semantic differences between anxiety and confidence, given the argument that they could very well be opposites of the same construct. If one considers the fact that 26 subjects (42% of the sample) did not speak English as a home language, which is the language that the attitude scale items are presented in, this explanation with regards to semantic differences can very well be feasible. In Fuller's (1997) study, no one in the sample spoke any other language other than English and Afrikaans, and the personality tests were offered in the medium of the respondent's choice. While presenting the questionnaire in alternative formats would have been ideal, the fact that the course was presented in English, led the researcher to believe that the respondents would feel comfortable with the medium of English.

However, and as an alternative to the language explanation, there are strong correlations between the sub-scales (refer to Table 9, section 7.3.). This would lean the debate towards the fact that the questions are more likely to be measuring the same construct as opposed to being influenced by different home languages of the respondents. Thus while language may have been an issue, it should not necessarily be the only consideration.

The present study's results would concur with Fuller (1997) and Woodrow (1991) however the present study, too, has limited sample size (N=62) and the factor structure could be misleading due to this fact rather than the instrument or the demographics of the sample. Considering this, and the fact that one can still differentiate a trend in the scales' factor loadings at least partially similar to that of the original factor loadings, one should not over-emphasise the lack of repeated factor structure as completely eliminating the reliability of the attitude scales, although they should be considered with caution.

8.3. The Influence of the Computer Course on Attitudes

Bearing the factor structure as well as the high correlations among the sub-scales and the overall scale itself in mind (Table 5, section 7.2.2. and Table 9, section 7.3.), the differentiation between the sub-scales needs to be interpreted with caution. Owing to the fact that these are highly correlated variables, with very little differentiation in terms of factors, the variables, when significant should be correlating with all the sub-scales, especially confidence and anxiety, which have been found, themselves, to be highly correlated.

While this in itself is a limitation, it is also important to note that whenever a significant sub-scale finding occurs, the overall total attitude score is usually found to be significant as well. This lends the author to confirm that the attitude scale is measuring overall negative/positive attitude towards computers sufficiently to make some reserved inferences about the findings.

8.3.1. Knowledge and usage of computers influencing attitudes

The analysis of variance in terms of prior knowledge and usage of computers and attitudes lead one to conclude that this has a positive impact on attitudes, however, subsequent to the course, this factor no longer bears significance (refer Table 14, section 7.6.1.). Thus trainers should be aware of the differences in knowledge between students, however, they should also feel comfortable in concluding that after the course, these differences in attitudes have been eliminated through the exposure of the student to the coursework.

The LSD analyses (Table 15, section 7.6.1.) present the understanding that there are significant differences in attitudes in terms of in anxiety, confidence, liking and overall attitude between those who have only seen computers being used before as well as those who have only used them in a limited way and those who have had a fair amount of exposure to computers in their daily living and used them accordingly. These results, therefore lead the researcher to accept hypothesis 1, that knowledge of computers and prior usage influence attitudes towards computers, thereby confirming that if one has used a computer before in some way, one has a more positive attitude towards it.

8.3.2. The influence of demographics on attitudes

"The relationships between various demographic variables and computer attitudes are varied" (Busch, 1995, p148). Based on previous literature hypotheses 2 and 3 delineated the expectations that gender and age would be significant variables in understanding attitudes towards computers.

8.3.2.1. Gender

Based on its non-significant t-test score (Table 10, section 7.4.1.), this study rejected the hypothesis that gender was an influencing variable on attitude towards computers. While gender has been found to influence maths anxiety, mixed results in past literature have been found as to whether gender has an impact on computer attitudes. The present study's results therefore concur with those of Loyd and Gressard (1984), Cohen and Waugh (1989), Kernan and Howard (1990), Parasuraman and Igbaria (1990) and Todman and Monaghan (1994) that there are no significant differences in computer attitudes between males and females and consequently do not concur with Colley et al (1994) and Whitley (1996).

8.3.2.2. Age

Age, on the other hand, was found to be significantly related to computer confidence, yet not to the other attitude scores (refer Table 16, section 7.6.2.). This then would be in partial support of hypothesis 3, however, owing to the inconsistent factor structure (Table 5, section 7.7.2.), this result is presented with reservation, especially considering the fact that overall computer attitude differences were not found to be significant in terms of the age variable.

This hypothesis was based on the premise that owing to the pervasiveness of computers in contemporary society, older adults might feel more threatened by new technology and may therefore be less willing to adapt, thereby exhibiting more negative attitudes towards computers (Jay and Willis, 1992). While the analysis of variance did not reveal significant results in the means of older and younger subjects, there was a significant negative correlation between age and confidence (-0.426; $p<0.01$) as well as overall attitudes towards computers (-0.300; $p<0.05$) (refer Table 9, section 7.3.). While the overall attitude variance explained was relatively weak ($r = 0.03$, therefore, $r^2 = 0.09$), this relationship is still significant and therefore warrants further discussion.

While Igbaria and Parasuraman (1989) found that age significantly correlated with attitudes. Rosen and Maguire (1990), upon conducting a meta-analysis of seventeen difference computer anxiety studies, found that age was a significant correlate of computer anxiety. Additionally, Fuller (1997) found in her study that age was significantly related to attitudes, in terms of confidence, liking and attitude as a whole. Thus while in the present study, liking and anxiety did not significantly correlate with age, confidence and overall attitudes towards computers did, thus partly agreeing with previous research on this variable.

As part of the additional analyses, the occupation variable was tested and found to be highly significantly related to computer attitudes, prior to the computer course, however not related subsequent to it (Table 18, section 7.6.3.). This variable can be considered to be a reflection of the age and education variables; essentially being an amalgamation of the age of the person, that being, the higher occupational type, the older the respondent, and the more education the person has, the more likely the person occupies a higher position in a company. The presentation of the significant Chi-squared statistic comparing the categories of these two variables with occupation is given at the end of section 7.6.3. resulting in the consideration of both these factors influencing a person's occupation (as was mentioned at the beginning of section 7.6. the education variable was non-significant on all attitude scales). To return to the discussion, while age was only significant for one of the sub-scales, the variable of occupation, which has been shown to be related to age as well as education has been shown to be significant in all attitude measures.

According to Table 18, section 7.6.3., those who were not working (such as home executives and those who were retired) were significantly more anxious and had differing overall attitudes towards computers than their working counterparts, at an entry level and middle management level. Additionally students varied significantly in terms of confidence, liking and overall attitudes towards computers, in comparison to most other occupation levels. However, this result should be considered with caution owing to the fact that there were only two students in the sample. Senior management and professionals also differed significantly from entry level occupations in terms of confidence and overall attitudes. Interestingly Fuller (1997) did not find a significant relationship between tenure and level of education with attitudes, post level was only significantly inversely related in terms of liking, however, this possibly could have been a result of the study focussing on the banking environment and her sample did not comprise of a large number of employees in management (only 16%).

These results have important implications for understanding computer attitudes. Firstly, most other research in the domain of computer attitudes have focussed on differences between novice and expert users, usually focussing on limited sample diversity. These results show that the occupational level of the respondent, which is also considered to be influenced by age and education level, to be an important consideration when attempting to understand computer attitudes. From this, trainers can show consideration and sensitivity for those who show more negative computer attitudes, in view of the fact that the controlled exposure to the computers ensures that these differences no longer exist subsequent to the course.

Differences in attitudes according to occupation were not hypothesised owing to the fact that other studies have mainly concentrated studies on students or on homogenous samples (Marcoulides et al, 1995). However, these results do shed some light on the fact that age was related to confidence and overall attitude. The hypothesised difference in attitudes according to age was based on previous research, which has found age to be a significant correlated with computer anxiety and attitudes in general (Igbaria and Parasuraman, 1989; Fuller, 1997). The occupation variable now qualifies the influence on attitudes in terms of age (being influenced by both education and age) and thus warrants consideration in future studies in this area.

8.3.2.3. Home Language

The influence of home language (not hypothesised) was found to be highly significant for anxiety and overall attitudes as well as significant for confidence and liking (Table 11, section 7.4.2.).

These results therefore lend the researcher to reiterate the now plausible inference that in South Africa, Whites and Blacks differ on computer attitudes, and while these may not be constant in the New South Africa, they are certainly prevalent in today's working environment. While this has been speculated in the past, the study confirms that differences exist in terms of attitudes towards computers according to language spoken at home. These results should be considered as guidelines for trainers to show sensitivity to those who have a more negative attitude towards computers prior to commencing computer courses, while at the same time recognising that the course will ensure that attitudes subsequent to the course are similar no matter what language one speaks (refer Table 11, section 7.4.2).

8.3.3. The change in attitudes

As demonstrated in Table 12 of the Matched pairs t-tests (section 7.4.3.) there is a significant change in overall attitudes towards computers of the respondents subsequent to the course, Hypothesis 4 is accepted. While it is necessary to hold the conclusion that computer confidence changed as a result of the course (due to the unreplicated sub-scale factor structure), there was a significant difference in means in overall attitude towards computers prior to the course and subsequent to it. The non-significant results of the Mann-Whitney U tests in terms of the control groups scores, on the other hand, fail to confirm this effect (Table 13, section 7.5.) and instead significantly deviate from the pre-test confidence ratings. The results therefore have not categorically confirmed that attitudes change as a result of the 'Basic Skills in Computers Course' training course in terms of controlled exposure to computers, as was originally hypothesised.

While no other study has specifically analysed a specific change in attitudes as an effect of a computer course, the literature when comparing novices and experts has demonstrated extensively that those who have interacted with computers before have more positive attitudes towards computers (Todman and Monaghan, 1994; Ray and Minch, 1990; Reznich, 1996; Crable et al, 1994). Marcoulides (1988), on the other hand, found that overall attitudes did not differ subsequent to a computer course.

8.3.4. <u>The stability of the control</u>

The relevance of the stability of the control now needs to be considered. While conclusions as to the effect of the computer course have been made with regard to the comparison between the computer attitude measures as well as prior to and subsequent to the course, more discussion is pertinent.

While a significant change in attitude was found, two of the three sub-scales, remained significantly unchanged, those of anxiety and liking. In other words, these constructs were not influenced by the computer course. While the factor structure of the computer attitude scales has been repeatedly mentioned in the results and discussion sections, as has the small control group size

(N=11), these may not be the only reasons why these sub-scales did not measure a change. Alternative hypotheses need to be considered.

For instance, as was discussed in section 3.3., Fuller (1997) and Igbaria and Parasuraman (1989) found a relationship between cognitive style and computer attitudes. These are more stable personality constructs that would possibly not be influenced by the interaction with computers such as was suggested in the literature to date. Additionally, with the statistical significance of the occupation variable, occupational type should also be considered. Thus while the course proposes to change attitudes, these may be unchangeable as a result of them being more stable constructs than anticipated. The course presenter, instead, should show an understanding of this fact, rather than expect attitudes towards computers to change. Interestingly as was shown in the control group, attitudes can still be negative regardless of computer experience and daily interaction with computers.

Furthermore, while the means of the attitude scores of the control group are statistically the same as those of the experimental group, the sample size is very small, selected on a basis of their lack of or very little knowledge and use of computers, with the aim of ensuring that they were similar to a group of people who would register for a basic skills in computing course. The possibility that on a larger sample, these attitudes could have been different to that of the experimental group cannot be reliably rejected. It is conceivable that these individuals have their various reasons for not registering for computer courses, possibly including the fact that they might very well have a more negative attitude towards computers, and possibly this is reflected in the significant difference in confidence scores. In a similar vein, the experimental group, due to the very fact that they are registering for a computer course, could have more positive attitudes towards computers and a larger control sample could possibly have revealed this.

8.3.5. Summary of computer attitude results

Thus in summary, the research results have shown that computer attitudes do change as a result of attending a computer course. Additionally, it has been shown that differences in age, home language and occupation influence computer attitudes displayed by individuals and relevant applications and comparisons to past research conclusions have been made in this regard.

8.4. The Influence of the Computer Course on Mental Models

8.4.1. Knowledge and usage of computers influencing mental models

On the basis of the finding of a non-significant Chi-square statistic with regards to the influence of prior knowledge and usage of computers on mental model construction, hypothesis 7 was rejected (section 7.7.2., Table 23).

Prior knowledge and usage of computers is one of the most researched variables influencing mental model construction and was considered an important prevailing variable that would influence mental models (Bibby, 1992). However, the results show that mental model construction varied non-significantly according to the knowledge/usage measure. Considering that most of the mental model changes occurred in a specific direction of complexity; that is, to the right in terms of categories (refer Table 20, section 7.7.1.), the fact that the knowledge/usage variable did not relate to mental models can easily be understood owing to the fact that the knowledge/usage variable does not increase in stages from least to most, left to right and it is these differences that the chi-squared statistic would calculate.

As was delineated in the literature review (O'Malley and Draper, 1992), knowledge and usage are so interwoven with the definition and conceptualisation of mental models, and it could have been this fact that lead to the non-significant differences between the two variables. This result could also indicate that up to a point, certain conceptual knowledge is not needed in order to interact with computers. As Wærn (1993) notes that certain users merely want to know how to use the system, rather than how it works.

Another alternative is that knowledge and usage of computers, ranging from never to often and for a variety of functions, on such a small sample, could very well lead to a non-significant difference in terms of mental models of respondents. Furthermore, the factors of respondents' prior experience, their exposure to other computer-like devices, their personality and attitudes towards computers could all influence the degree to which an individual seeks out computers in order to conceptualise them, thus leading to a non-significant difference between knowledge/usage and mental model conceptualisations. While the elaboration of the above variables were beyond the primary aim of the present research, they certainly provide options for areas for future studies to explore.

8.4.2. Demographics and mental models

8.4.2.1. Gender, age and home language

Correspondence analyses were conducted on all demographic variables, with non-significant results. While relationships were not hypothesised, on a South African sample, it would be expected that home language would have an influence on whether the user had been exposed to computers as well as how much knowledge they have and how much they have used computers. These results would indicate therefore that computers have become so pervasive in South Africa, that most people know what they are, have used them in some way, no matter what their home language or background. This conclusion could however be limited to the Johannesburg population as opposed to a rural sample or one that is possibly of a city that is not similar to Johannesburg. Additionally, in order to access a sample of people who were about to attend a 'basics in computers' course, certain limitations of sampling are imposed. The computer centre was situated in Randburg; possibly a sample of less socio-economic status would be found in the township areas such as Soweto, Tembisa or Alexandra.

8.4.2.2. Influence of prior exposure to computer-like devices

It was hypothesised that knowledge of computer-like devices would relate to mental models, however, this was not the case (Table 23, section 7.7.2.). It was found that only prior exposure to computers had an influence on mental models, in terms of whether the respondent had either seen, used or owned a computer. The significant result of prior exposure to computers (Table 25, section 7.7.3.) implies that the interaction between the individual and the computer is more of an influencing variable, as opposed to their knowledge and use of the computer at a specific level (e.g.: limited or in a variety of applications). Additionally, the complexity of the mental models was related to prior exposure to computers, thus partially supporting hypothesis 6. This therefore means that the difference between having only seen a device, rather than having interacted with it, or alternatively owned is important to the construction of a mental model, rather than the *degree* of knowledge and/or prior use. In terms of computer courses, this would then indicate that the actual application that one has worked on has less of an influence than if one has not used the computer at all. Trainers should take cognisance of this observation.

8.4.3. The change in mental models

As hypothesised in hypothesis 8, the mental model conceptualisations changed significantly as a result of the computer course. These results indicate that upon interacting with the computer, individuals begin to conceptualise what they are working with in a different way to that they were previously, and these conceptualisations improve in complexity indicated by a movement to the right in Table 20, section 7.7.1.

Furthermore, it is only when one fully understands and has an accurate and confirmed mental model of the device with which one is working that these conceptualisations stop changing or being modified (refer figure 7, top right quadrant). While this has been hypothesised in the literature, no one has actually confirmed this change in terms of actual course intervention and of naïve and novice computer users.

These results divulge important information about the nature of mental models of users. Firstly, mental models are not consistent, they are modified and re-appraised once the person interacts with the device concerned. These findings then concur with the literature, which states that mental models are dynamic, ever-changing with new knowledge (Borgman, 1986; O'Malley and Draper, 1992; Booth and Brown, 1990).

Additionally, mental models are formed and adapted without the specific intention of the course presenter nor the user specifically attempting to understand the computer. These results are revealed by the fact that mental model conceptualisations did not change with the control group (Figure 10, section 7.7.4., and therefore the influence of the testing situation as an alternative hypothesis is rejected, thereby leading to the conclusion that it was the interaction of the course that influenced the change as opposed to the user having tap into and draw their mental model in the testing situation.

8.4.4. <u>The stability of the control</u>

Figure 10 (section 7.7.4) indicates that there was little difference in distribution of mental model categorisations between the pre-intervention mental models of the control group and the post-intervention measures for a similar time period to that of the experimental condition.

These results should still be considered with caution. Firstly the control group comprised of a small number of subjects and the results of a larger sample could have revealed that it was a result of the testing situation, and not the computer course, that caused the mental models to change; two people in the control sample did actually change their mental model conceptualisations (one from a category 1 to 2 and the other from a 4 to a 5). The sample size of the post-intervention group is also small, indicating that results may not be generalisable or form a normal curve representing the population.

Additionally the control group were selected on the basis of being similar in terms of demographic variables as that of the experimental group. This sample of convenience could very well also have conceptualised the computer in a similar way to the experimental group based on this fact, rather than because they were similar in attitudes and mental models as the experimental group. However, this is unlikely to be the case, owing to the fact that demographic variables were not found to influence mental model conceptualisations. Included in these demographics that were matched was ensuring that the sample consisted of a range of users with prior knowledge of computers similar to that of the sample. Thus by the fact that the control groups' mental models remained consisted, the controlled exposure of the computing course is given further weight in terms of its influence on mental model changes.

8.4.5. Summary of mental models results

In summary therefore the study has shown that mental models of computer users change significantly after interaction with a computer in a computer course. Furthermore prior exposure to computers in terms of having seen, used or owned a computer influences the conceptualisation of the user, while prior knowledge/usage of computers does not. Demographic variables do not have a relationship with how a person conceptualised the computer.

CHAPTER 9: IMPLICATIONS, LIMITATIONS AND CONCLUSIONS

9.1. Chapter summary

The aim of this chapter is to bring together the essence of the present study's conclusions in line with those of both practical and theoretical knowledge while at the same time recognising its limitations and outlining directions for future research. Finally conclusions will be made in the last section as a final summary of the research that was conducted.

9.2. Implications

Having now discussed, in the previous chapter, the results and the subsequent conclusions that can be drawn as a result, it seems pertinent to highlight in more detail the implications that they have in terms of both practical and theoretical advancement.

9.2.1. Practical Implications

The present study has important ramifications for computer training in organisations in terms of both attitudes and mental conceptualisations. Firstly, it has been shown that computer attitudes towards computers changed as a result of a basic skills in computers training course. This has important implications for trainers, who find themselves faced with class members who have a negative attitude towards computers when they first encounter them

(Anderson, 1996). Furthermore, it has also statistically been established that gender does not have a significant relationship with these computer attitudes, nor does marital status. On the other hand the variables of home language, occupation and to some extent age, do have a bearing on attitudes and these relationships have important implications in terms of the sensitivity that trainers can display towards those who have been shown to have more negative attitudes (Crable et al, 1994), for instance senior managers and Black trainees. The trainers can also pitch the sessions according to the understanding that home language and occupation of the trainees influenced attitudes.

Additionally all these differences were only present before the computer course, thereby indicating that the trainer can feel comfortable in the fact that the course will have the desired effect on the attitudes of the trainees.

The significant cognitive change of the respondents also has important practical implications for trainers. Trainers can utilise the now validated knowledge that users of computers have a mental model of the computer once they have interacted with it and it changes as a result of the computer training course.

Mental model conceptualisations also propose important implications for course structure. Now that it has been exhibited that mental models definitely change as a result of course intervention, improvements in presentation of course material could possibly be made. For instance relevant conceptual models can be given to aid formation and development of accurate mental models, and sensitivity toward mental model development can be shown in training sessions.

The present study has also shed some light on the issue of prior exposure as well as knowledge and/or usage of computers and their influence on mental models. While knowledge of computers and their prior use had no bearing on conceptualisations, the influence of the person's previous *exposure* influenced the way the person conceptualised the computer.

9.2.2. Theoretical Implications

The present study has shown that computer attitudes are not related to gender but rather are influenced by occupation, home language, to a certain extent age and also by knowledge and previous use of computers. Thus showing that models of influencing variables on computer attitudes should include these variables and abandon the idea that gender influences attitudes or more specifically anxiety.

The research has also indicated that computer attitudes will change as a result of a computer course. While the control group did not confirm this effect, the conclusions that can be drawn about these comparisons are limited by its small sample size.

The idea that attitudes towards computers could be a more stable construct has been suggested as an alternative hypothesis to the present study and this offers corroborative results with previous studies such as Igbaria and Parasuraman (1989), Bozionelos (1997) and Fuller (1997) that computer attitudes are related to personality characteristics such as cognitive style and spontaneity.

The theory of mental models hotly debates the issue of knowledge and its relationship with mental models (Staggers and Norcio, 1993; Koping, 1995; Norman, 1983). The present research contributes the understanding that when a user has never used a computer before, their mental model of it will differ from that of the person who has used it before, as well as his/her mental model in turn differing from that of the person who has owned a computer before. At the same time it shows that the degree of prior exposure in terms of knowledge and use does not influence the construction of the mental model.

Furthermore, the nature of mental models has been explicated to a large degree in the present study. For instance, it has been shown that conceptualisations of computers can, but do not necessarily always occur without prior interaction with computers. Additionally, people can change, and adapt their mental model once they have interacted with the system, and it is only once they have interacted with the system in a controlled setting that this occurs.

It has also been shown that drawings of conceptualisations are an effective way of eliciting mental models which should be considered in future research as an alternative method to verbal protocols and observation.

The influence of demographics on mental model acquisition and conceptualisation also has important theoretical implications. These variables, for a variety of reasons have been studied as possible influencing variables. Owing to the sound research design, an understanding that the variables of gender, home language, age and occupation not having a relationship with mental models will be able to influence future conclusions with regard to mental model theory.

Finally the present study has shown that training has an important role to play in changing both attitudes and conceptual understanding of computer users. Thus the value placed in training has been shown to be a valid one, with the effect that the training offered in computer courses can change both the users attitudes towards computers as well as their mental models and thus should be considered as a viable option in both the business and teaching environments.

9.3. Limitations

While some limitations of the present research have already been highlighted, where relevant, in the discussion of the present research, the following section aims to delineate these more specifically.

The aim of the present study was to make a concerted effort to acquire a sample that was representative of the population. Several limitations to the study were imposed by this decision. Firstly, sample size (N=62) was limited to the number of people registering for the 'Basics in computing course' at the organisation that were running the course. While additional organisations were approached, only one was interested in aiding the researcher with her research. Additionally, the small post-intervention sample further limited the generalisability of the conclusions the research.

Secondly, this was the first time that the Loyd and Gressard scale had been used on a diverse sample group, one that was composed of 40% non-English speaking individuals. This, as was highlighted earlier, could have influenced the factor structure of the attitude scale. The lack of repeated factor structure limited the strength of the research findings in that the sub-scale findings could not be upheld with confidence. Furthermore, Fuller's (1997) study also failed to substantiate the factor composition, which should caution future researchers and suggest that they possibly reassess its use in South Africa.

The results of the intervention of the computer course indicated that overall attitude towards computers of respondents changed. However, non-significant differences were found with the computer anxiety and computer liking sub-scales. This would indicate that over a period of time, computer attitudes can remain the same, thus these variables could be more stable than hypothesised. Also indicating this suggestion is the lack of statistical difference between the control's attitudes scores and that of the post-intervention attitude measure. These would then tie in with Fuller's (1997) study and Marcoulides (1988) which indicated that attitudes are related to more stable constructs such as sensing/intuition and thinking/feeling variables, which would mean that while courses will not alter computer attitudes, course presenters should be sensitive to the differing computer attitudes that are present in beginners computer courses and thereby, while not managing to alter these attitudes, showing sensitivity towards their existence.

As an alternative to attitudes being more stable, the measure of computer attitudes could be failing to measure differences. Owing to the fact that no test-retest reliabilities are available for this measure, this alternative can neither be confirmed nor rejected.

Several limitations were imposed by the measure of respondent's knowledge/usage of computers and prior exposure to computers. While other studies have used other types of measures, including explicating functionalities that they use on the computer (such as word-processing, e-mail, spreadsheets, databases and/or worked off PC's or main frames), whether the person has been on a computer course before or a rating of personal competence on the computer (Maurer, 1994; Fuller, 1997; Staggers and Norcio, 1993; Larkin, 1983), while these options were carefully considered, owing to the nature of the sample (some having never interacted with a computer before), they were not feasible alternatives.

Additionally, the clusters for the knowledge/usage variable that were chosen, while raters' clustering was reflected as being highly significant (κ=0.73), could have been too discrete (possibly cluster one, two and three could have been combined and maybe five and six). Secondly, the knowledge/usage variable did not consider whether the subject had only seen or used or owned a computer in the clustering and instead considered these as a separate variable.

The significant result of prior exposure to computers implies that the interaction between the individual and the computer is more of an influencing variable, as opposed to their knowledge and use of the computer at a specific level (e.g.: limited or in a variety of applications). This therefore means that the difference between having only seen a device, rather than having interacted with it, or alternatively owned is important to the construction of a mental model, rather than the degree of knowledge and/or prior use. This does not concur with previous research and therefore warrants further discussion.

Owing to the nature of the question: "What is under the lid of the computer box", if someone has owned a computer, and had to buy the computer on a basis of its components (for instance increased hard drive capacity, upgraded memory), the person could very easily know a little more about what is under the lid of a computer box, because of necessity as opposed to having a better mental model. However, on the other hand, someone who owns a computer, has probably used them for longer than a person who uses them sometimes at work; the person has made a concerted effort to go and buy a computer for their home use. Thus the time factor of how long a person has been using a computer could become a related factor to the complexity of the mental model, and while it was expected to come out in the knowledge/usage variable, this was not the case. As a result of this argument, the issue of whether the two variables should not have been incorporated into one, again is questioned and is left to be resolved in further research.

It was presented in the literature that it is generally accepted that people have mental models, even if they have never interacted with the computer before (Borgman, 1986). However, seventeen of the subjects failed to draw their conceptualisations of the computer. This could have impacted on the results and therefore warrants further debate.

Several factors could have impinged on respondents not drawing their conceptualisation of the computer. First of all and in contradiction to the presented literature, these people could possibly not have any idea whatsoever about what was under the lid of the computer box. Alternatively, they possibly did not wish to access their mental model, for fear of being wrong, perhaps indicating a good-subject effect (Rosenthal and Rosnow, 1991). While the questionnaire did emphasise that there was no right or wrong answer to the question, this is still a plausible option.

The research question that was used could also have impinged on the respondents not answering the mental models question. Koping (1995) used the question with great success in her study and thus the question was considered to have reliability for South African respondents. However, in comparison to Koping's (1995) methodology, the present researcher did not interact at all with the respondents and this interaction could have led to a lack of subject-experimenter artefacts that may have arisen in Koping's study. These could have been those of subject altruism, evaluation apprehension and obedience as well as interactional experimenter effects (Rosenthal and Rosnow, 1991). Essentially these outline that findings are prone to bias as a result of the subject feeling the need to perform under the scrutiny of the researcher, and similarly the experimenter can impose modelling on the subject or, alternatively, they can be influenced psycho-social effects of personality and warmth offered by the experimenter. These issues would influence the success of the methodology used by the experimenter and therefore influence the possible lack of success of the same method of mental model elicitation in the present study. Further studies utilising this research question on a larger sample size are therefore called for.

Another research issue that needs to be considered is the effect of the non-response bias on the results of the study. In order to assess this, the researcher excluded the first mental model category from the study (as was mentioned in the methodology). No significant differences in results were found when this occurred. In other words, the changes in mental model conceptualisations after the course still existed.

In order to address some of the above limitations, suggestions for future research are now made in the ensuing section.

9.4. Directions for future research

The implications of these results as well as the limitations that have been delineated offer opportunity for further studies.

Firstly, occupational type, which is reflective of age and education warrants further disclosure in future studies. Additionally, owing to the fact that the computer attitude variables did not change sufficiently when compared to the control group, the stability of the concept of the computer attitude needs to be assessed in terms of its relatedness to personality characteristics and as well as occupational type. The stability of the attitude variable could possibly be researched with more longitudinal and time-series research designs thereby assessing the consistency of these attitudes over time and applying the research conclusions of Fuller (1997) and the present study under further scrutiny.

Home language was found to be an important variable influencing computer attitudes. With the proliferation of computers in the modern workplace as well as in the every day environment of South Africans, this is important to understand and render an appropriate response and/or consideration. Bearing the results of the present research in mind, this could be in the form of training as mere exposure to computers which has been shown to influence computer attitudes positively.

Drawings proved to be a successful method of mental model assessment all the while the specific *research question* was debated. Specifically this was in terms of it possibly being influenced by prior exposure to computers, as opposed to knowledge and usage, as well as the fact that it was debated that, up to a point, conceptual knowledge is not needed in order to operate a device, therefore rendering the question to lack face validity. It is suggested therefore that further research utilise this research question on a larger sample, and again without the subject-experimenter artefacts that could have rendered it successful in Koping's (1995) study.

Finally, what is suggested in future research is that more care is taken to extricate a suitable understanding of the person's prior exposure, their use of as well as their knowledge of computers in the questionnaire, in order to develop a greater understanding of the respondent's experience of computers. This is especially important in terms of first time adult computer users who could have had a varied exposure, knowledge and prior use of computers all of which could effect their mental model of computers.

9.5. Conclusion

> Our age is the computer age, and human interaction with an increasing proportion of modern system entails either direct dialog with a computer system or the use of devices that incorporate artificial intelligence.
>
> Gopher and Kimchi, 1989, p431

With the proliferation of computers everywhere people go, an understanding of their attitudes towards these computers as well as their mental conceptualisations of them are vitally important.

While many studies have attempted to study these variables, these studies usually have been limited to student samples and ungeneralisable research designs. Thus the present study aimed to address these issues in terms of a representative sample and a sound research design and consequently produced results that are reliable, with most alternative hypotheses having been eliminated.

It was found that both attitudes as well as mental models changed as a result of computer interaction in the training course. However, while the control group stayed significantly the same in a similar time period for mental models, the control group for attitudes changed in terms of one of the sub-scales; confidence. Additionally, various demographic variables were found to influence the attitudes of computer users, specifically age, home language and occupation. While knowledge and usage of computers was found to be a significant variable with regards to attitudes, it was not found to be related to mental models.

The above findings can provide important information on the effective integration and acceptance of computers into the evolving workplace. It is in the interest of trainers and organisations alike to utilise the understanding of computer users that this study offers in terms of more effective as well as sensitive training offered to computer users (Crable et al, 1994). Ultimately the organisation will find that their productivity, their competitiveness and the realisation of human potential will be effective if they take cognisance of these research findings.

While the research sample was limited, it still concurred most of its findings in terms of a control sample. Furthermore, the exploratory nature of the research into new sample demographics yet still yielding the positive results is promising for future researchers.

Thus it can be said that the research presented here has shown itself to contribute vastly to both theory and understanding of computer users and consequently to human computer interaction in general.

CHAPTER 10: REFERENCES

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APPENDIX A

UNIVERSITY OF THE WITWATERSRAND

DEPARTMENT OF INDUSTRIAL PSYCHOLOGY

PRIVATE AND CONFIDENTIAL

INSTRUCTION: Please fill in the following information:

Name: ______________________________ (necessary for follow up reasons and to qualify answers only)

Date of Birth:

Y	Y	M	M	D	D

Gender: ________________ Marital Status: ____________________

Home Language: ______________________ Occupation: ____________________

Highest Education Level:

Std 8	Std 10	Diploma	Degree	PGradDegree

INSTRUCTION: Please tick in the appropriate box

Have you ever seen, used or owned any of the following devices?

	Seen	Used	Owned
Typewriter			
Calculator			
Cash Register			
Automatic Teller Machine (ATM)			
Video Game			
Computer			

Please now explain your previous contact with computers (for instance, in the library/bank/home, seen children/colleagues/friends use them) ____

____

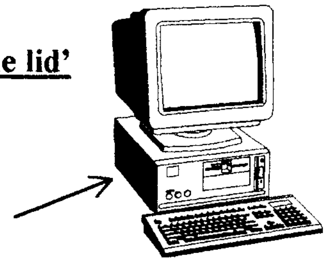
____

____

INSTRUCTION: Please answer all of the following questions. Tick one answer per question

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Computers do not scare me at all				
2. Working with a computer would make me very nervous				
3. I do not feel threatened when others talk about computers				
4. I feel aggressive and hostile towards computers				
5. It wouldn't bother me at all to take computer courses				
6. Computers make me feel uncomfortable				
7. I would feel at ease in a computer class				
8. I get a sinking feeling when I think of trying to use a computer				
9. I would feel comfortable working with a computer				
10. Computers make me feel uneasy and confused				
11. I'm no good with computers				
12. Generally, I would feel OK about trying a new problem on the computer				
13. I don't think I would do advanced computer work				
14. I am sure I could do work with computers				
15. I'm not the type to do well with computers				
16. I am sure I could learn a computer language				
17. I think using a computer would be very hard for me				
18. I could get good grades in computer courses				
19. I do not think I could handle a computer course				
20. I have a lot of self-confidence when to comes to working with computers				
21. I would like working with computers				
22. The challenge of solving problems with computers does not appeal to me				
23. I think working with computers would be enjoyable and stimulating				
24. Figuring out computer problems does not appeal to me				
25. When there is a problem with a computer that I can't immediately solve, I would stick with it until I have the answer				
26. I don't understand how some people can spend so much time working with computers and seem to enjoy it				
27. Once I start to work with the computer I find it hard to stop				
28. I will do as little work on the computer as possible				
29. If a problem is left unsolved in a computer case, I would continue to think about it afterward				
30. I do not enjoy talking with others about computers				

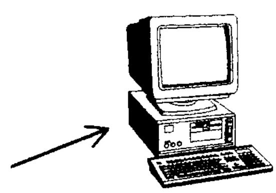
<u>INSTRUCTION</u>: <u>Please could you draw what YOU THINK is 'under the lid' of the 'computer box'.</u>



- **<u>Please LABEL all the aspects of your drawing</u>**

There is no right or wrong answer to this question

<u>Under the 'lid' of the computer box</u>



INSTRUCTION: Please now write a description of what you have drawn

Thank you for your co-operation

APPENDIX B

UNIVERSITY OF THE WITWATERSRAND

DEPARTMENT OF INDUSTRIAL PSYCHOLOGY

PRIVATE AND CONFIDENTIAL

INSTRUCTION: Please fill in the following information:

Name: ______________________________ (necessary for follow up reasons and to qualify answers only)

Date of Birth:

Y	Y	M	M	D	D

Today's date: ____________________

Gender: ________________

Home Language: ________________________

INSTRUCTION: Please tick in the appropriate box/es

Since my computer course I have used a computer for the following amount of time for home use, business use or another use:

You may tick in more than one box.

	Home	Business	Other
0 – half an hour			
half an hour – one hour			
one hour – two hours			
two hours – three hours			
three hours – four hours			
More than four hours			

Please now explain why you have used the computer for the times that you have stated.
For example little access/ no time/ business has made you use it/ you feel more confident/ been sick.

____

____

____

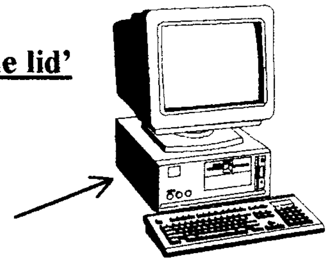
____

INSTRUCTION: Please answer all of the following questions. TICK one answer per question

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Computers do not scare me at all				
2. Working with a computer would make me very nervous				
3. I do not feel threatened when others talk about computers				
4. I feel aggressive and hostile towards computers				
5. It wouldn't bother me at all to take computer courses				
6. Computers make me feel uncomfortable				
7. I would feel at ease in a computer class				
8. I get a sinking feeling when I think of trying to use a computer				
9. I would feel comfortable working with a computer				
10. Computers make me feel uneasy and confused				
11. I'm no good with computers				
12. Generally, I would feel OK about trying a new problem on the computer				
13. I don't think I would do advanced computer work				
14. I am sure I could do work with computers				
15. I'm not the type to do well with computers				
16. I am sure I could learn a computer language				
17. I think using a computer would be very hard for me				
18. I could get good grades in computer courses				
19. I do not think I could handle a computer course				
20. I have a lot of self-confidence when to comes to working with computers				
21. I would like working with computers				
22. The challenge of solving problems with computers does not appeal to me				
23. I think working with computers would be enjoyable and stimulating				
24. Figuring out computer problems does not appeal to me				
25. When there is a problem with a computer that I can't immediately solve, I would stick with it until I have the answer				
26. I don't understand how some people can spend so much time working with computers and seem to enjoy it				
27. Once I start to work with the computer I find it hard to stop				
28. I will do as little work on the computer as possible				
29. If a problem is left unsolved in a computer case, I would continue to think about it afterward				
30. I do not enjoy talking with others about computers				

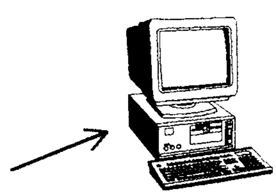
INSTRUCTION: **Please could you draw what YOU THINK is 'under the lid' of the 'computer box'.**

- **Please LABEL all the aspects of your drawing**



There is no right or wrong answer to this question

Under the 'lid' of the computer box



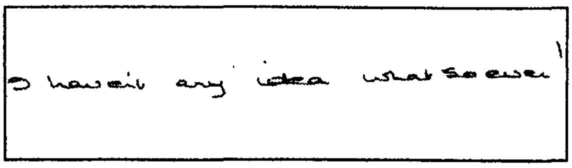
INSTRUCTION: Please now write a description of what you have drawn

Thank you for your co-operation

APPENDIX C

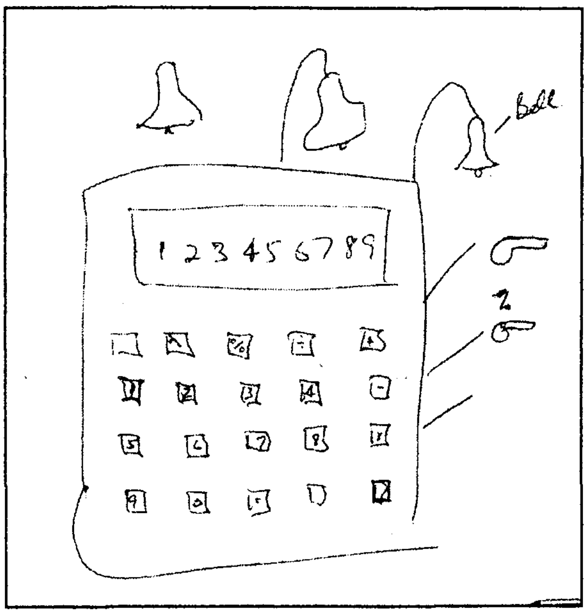
Mental Model Drawings

Category 1: **No conceptual idea**

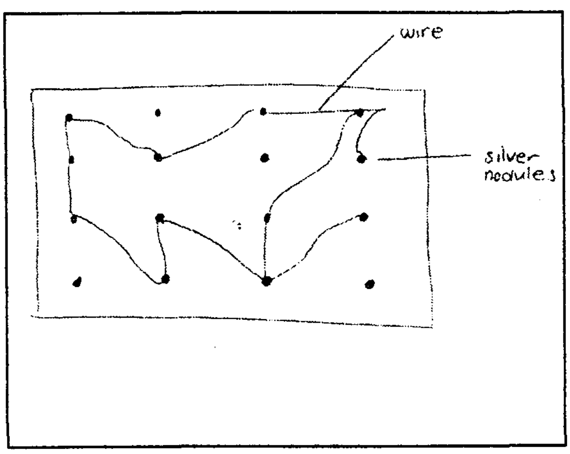


Respondent 15

Category 2: **Drawn a simple diagram of an electronic device**

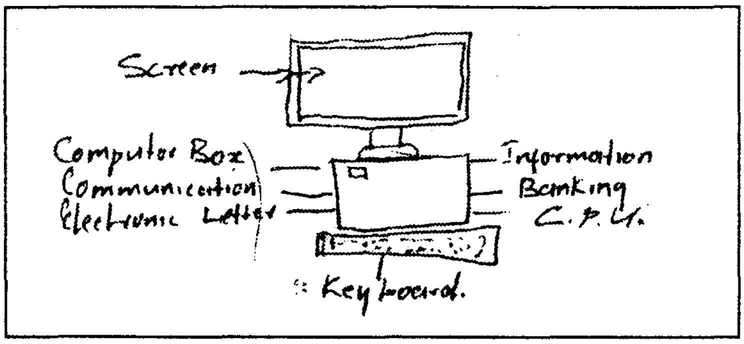


Respondent 45



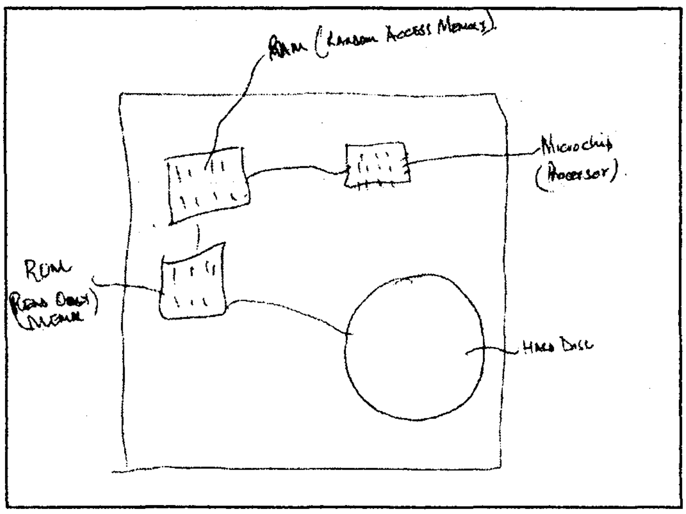
Respondent 1

Category 3: **Drawn a simple computer but labelled it with electronic jargon or computer functionality and no direct association with internal features**

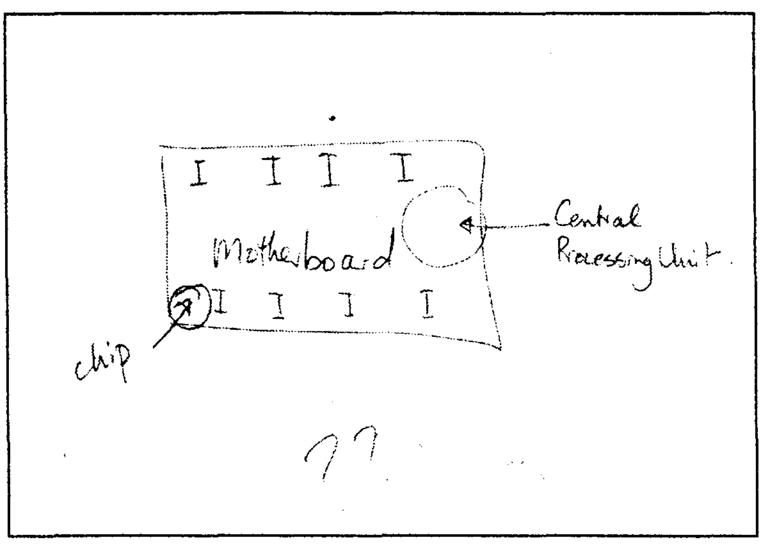


Respondent 38

Category 4: **Drawn a computer box, very simple and included only one or two features.**

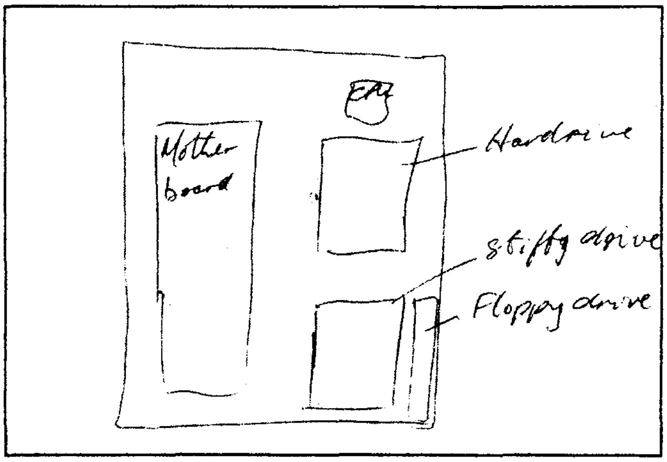


Respondent 24

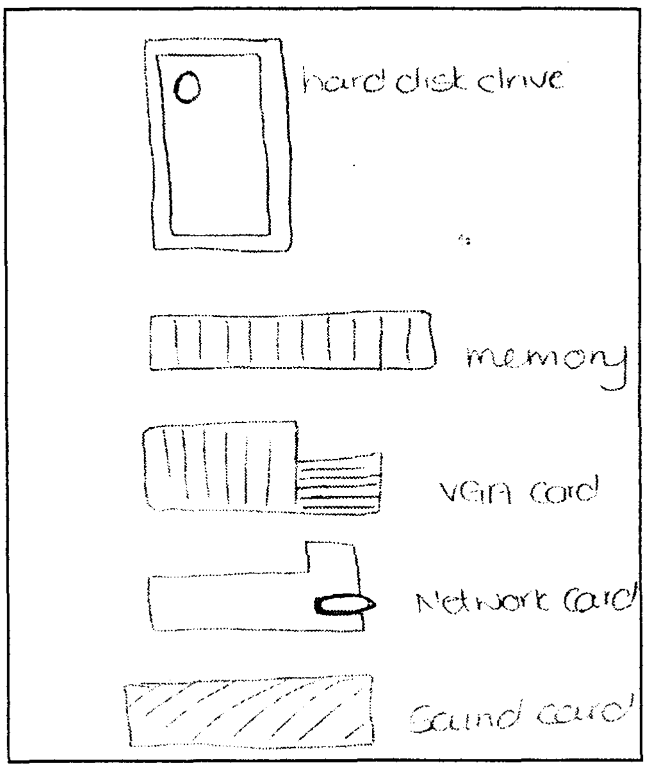


Respondent 42

Category 5: **Drawn a computer box, but missing some essential elements for operation, only three or four features.**

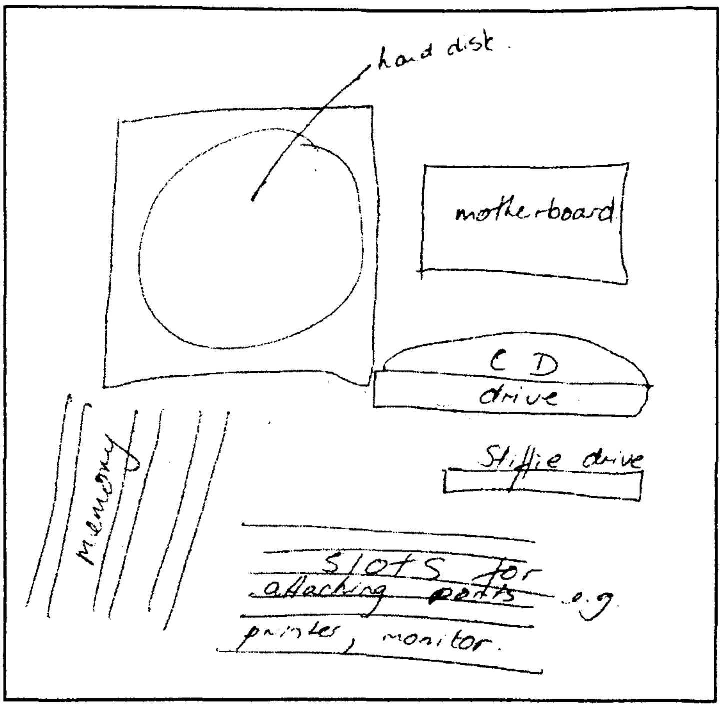


Respondent 29

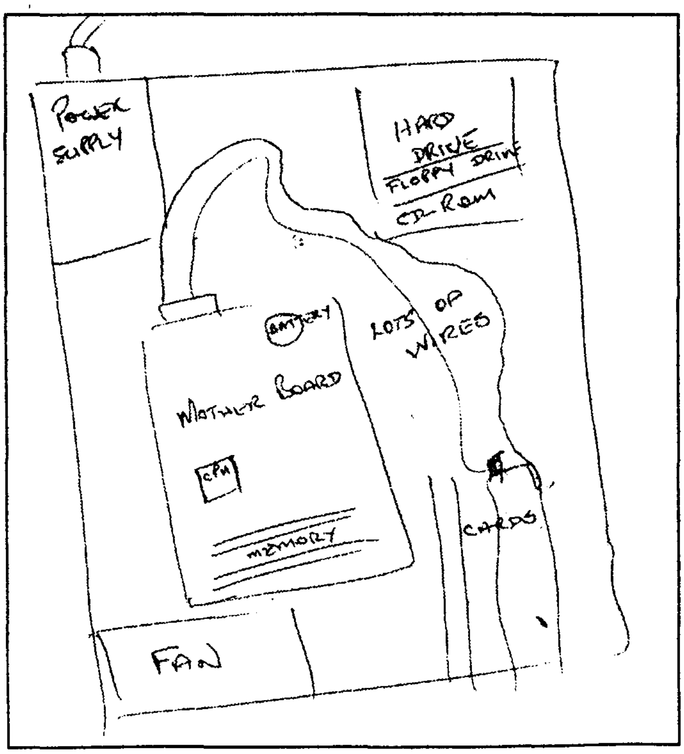


Respondent 8

Category 6: **Drawn what is inside a computer box, fairly comprehensive, included five or six features.**



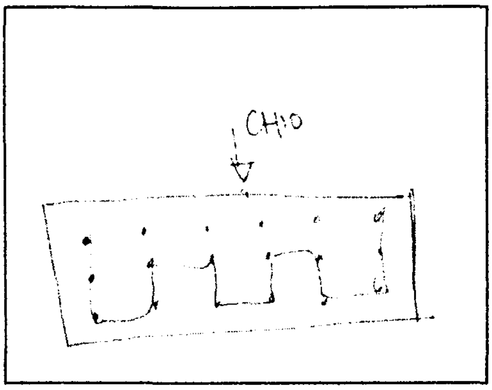
Respondent 49



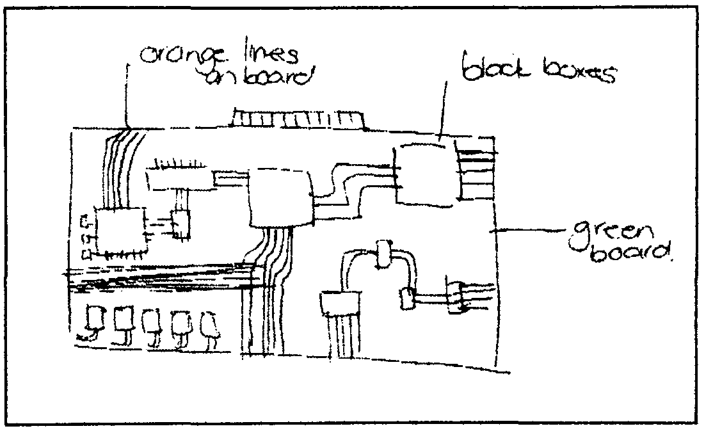
Respondent 23

APPENDIX D

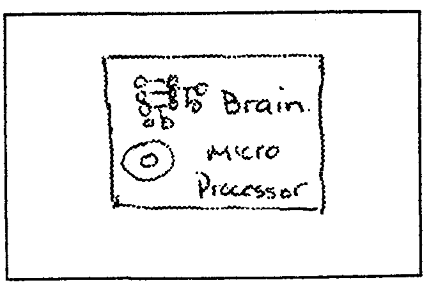
Examples of Mental Model changes



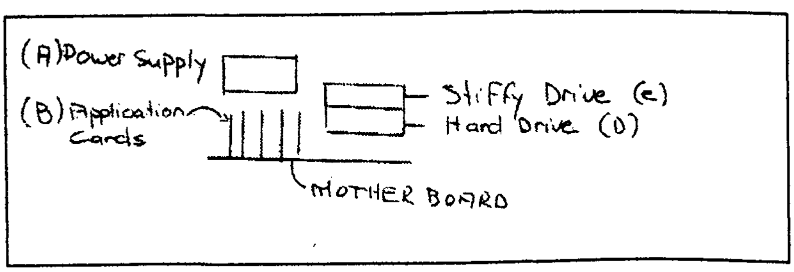
Respondent 2
Pre-intervention Mental Model



Respondent 2 : Post-intervention mental model



Respondent 43 pre-intervention mental model



Respondent 43
post- intervention
mental model