Order Number 9202377

The reduction of computer anxiety: Its relation to relaxation training, previous computer training, achievement and need for cognition

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Iowa State University, 1991

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The reduction of computer anxiety: Its relation to relaxation training, previous computer training, achievement and need for cognition

by

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A Dissertation Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Department: Curriculum and Instruction
Major: Education (Curriculum and Instructional Technology)

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Department

Signature was redacted for privacy.

For the Education Major

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1991

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INTRODUCTION

> Change always involves uncertainty and displacement, which consequently produces trauma. But change is also an essential component of growth, so it must not be discouraged. (Amdahl, 1986, p. 38)

This chapter has six major sections. The first section contains background information about why computer anxiety is important, and a general overview of the research in the area. The second section contains the statement of the problem. The third section describes the purpose of the study, and the fourth section lists the research hypotheses. Next, the basic assumptions made in this study are explained, and the last section presents the limitations of the study.

Background

> Computers call up strong feelings, even for those who are not in direct contact with them. People sense the presence of something new and exciting. But they fear the machine as powerful and threatening. (Turkle, 1984, p. 13)

Computers are an integral part of our society. The use of computers is rapidly becoming a basic skill. Apprehension or fear of computers and even reticence to use computers are components of what is called computer anxiety. Computer anxiety stands in the way of many who have a desire and often a need to master this most recent basic skill (Widmer & Parker, 1984).

In the past 10 years, the topic of computer anxiety has been one that has gained increased attention in the research literature. Numerous studies have been published on the subject, exploring computer anxiety from many different aspects. Studies have focused on the development of measures of computer anxiety (e.g., Loyd & Gressard, 1984b; Maurer, 1983; Oeting, 1983; Rohner, 1982), the psychometric properties of these measures (e.g., Bandalos & Benson, 1990; Dukes, Discenza, & Couger, 1989; Pilotte & Gable, 1989) and the relationship of computer anxiety to other personality or demographic variables (e.g., Bellando &Winer, 1985; Issa & Lorentz, 1989).

The construct of computer anxiety has been defined in a number of studies (Jay, 1981; Loyd & Gressard, 1984a; Maurer, 1983; Raub, 1981; Rohner, 1981a; Weil, Rosen & Sears, 1987). Further, the construct has been operationalized by a number of measures. Several researchers have developed ad hoc tests for the purpose of a single study (Cambre & Cook, 1987; Campbell & Perry, 1988; Dambrot, Watkins-Malek, Silling, Marshall, & Garver,1985; Issa & Lorentz, 1989; Mackowiak, 1988; Vredenburg, Flett, Krames & Pliner 1984). Others have used a more careful and thorough process when developing measures that would be appropriate for a wider range of use (Loyd & Gressard, 1984a; Marcoulides, 1989; Maurer, 1983; Meier, 1988; Rosen, Sears & Weil, 1987). All of these researchers concluded that relatively high levels of computer anxiety existed in a significant number of the individuals involved in their studies.

Much of the work that has been reported thus far in the area of computer anxiety relates to the development of the construct. Studies have examined relationships between computer anxiety and other related factors like math anxiety, general anxiety or computer experience (Maurer, 1983; Gressard & Loyd, 1984; Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Rosen, Sears & Weil, 1987; Marcoulides, 1988; Munger & Loyd, 1989; Kernan & Howard, 1990).

The bulk of the remainder of the work that has been reported in this area examines the relationship of computer anxiety to demographic and personality variables (Raub, 1981; Lamb, 1984; Loyd & Gressard, 1984a; Collins, 1985; Belando & Winer, 1985; Gressard & Loyd, 1985; Griswold, 1985; Cambre & Cook, 1987; Koohang, 1987; Loyd & Gressard, 1987; Rosen, Sears & Weil, 1987, Cambre & Cook, 1987, Francis, 1987; Honeyman & White, 1987; Rosen, Sears & Weil, 1987; Sievert, Albritton, Roper & Clayton, 1988;

Sievert, Albritton, Roper & Clayton, 1988; Wallace, 1988; Mackowiak, 1989; Kuhn, 1989; Hawk, 1989). Demographics that have been examined include gender, age and academic major. The findings in this area were mixed. Some studies found that males had lower computer anxiety, while other studies found no relationship between gender and computer anxiety. Some studies found lower anxiety in younger subjects, while other studies did not. A few studies found relationships between academic major and computer anxiety. Subjects in more technically related majors were found to be less computer anxious than those in less technically related majors. Personality variables that have been examined include hemisphericity, locus of control and Holland type. The studies in this area are few and their findings are not conclusive (see the second chapter for further details on these relationships).

One personality variable that has not been examined with respect to computer anxiety is need for cognition. This personality trait was operationalized by Cacioppo and Petty (1982). Their measure attempted to "identify differences among individuals in their tendency to engage in and enjoy thinking" (p. 116). Since computers are considered cognitive devices (Dede, 1987), this personality trait may well be more useful in determining who can benefit most from any specific computer anxiety reduction program than other personality variables previously examined.

Several studies have looked at the change in computer anxiety as a result of involvement in computer related instruction (Jones & Wall, 1985; Thompson, 1985; Chapline & Turkel, 1986; Cambre & Cook, 1987; Honeyman & White, 1987; Wallace, 1988; Lambert & Lenthall, 1989). The results of these studies were mixed, with some studies reporting a significant decrease in computer anxiety while others found no change. The majority of the studies that found no change involved a short duration class (workshops and short courses), and the majority of those that reported a significant change evaluated the impact of longer courses (full semester courses). The preponderance of evidence supports the hypothesis that treatments of longer duration are be more effective in reducing computer anxiety than treatments of shorter duration.

Most of the research mentioned above was justified on the basis of computer anxiety being an important concern in modern society. A large majority of researchers mention the possibility, or probability, that high levels of computer anxiety significantly handicap the individual with that anxiety. Loyd and Gressard, when discussing computer attitudes, stated "attitudes such as these may inhibit successful mastery of computer skills in much the same way that math anxiety inhibits achievement in mathematics" (1984a, p. 67). Rosen, Sears and Weil stated "for many people, the computer represents a barrier to both educational and employment opportunities, and they see it as a threatening intruder into their lives" (1987, p. 167). These two argument supporting the importance of studying computer anxiety are logical ones, but they are unsupported by research. Other researchers cite previous research in supporting the importance of examining computer anxiety. Koohang, when interpreting previous research stated "several recent studies have suggested that negative attitudes toward computers influence the learning process" (1987, p. 145). Marcoulides makes a similar claim, "researchers have indicated that negative emotional reactions toward computers influence the degree to which computers can effectively be utilized" (1988, p. 152). The research to which the previous two quotes relate merely put forward suppositions of the negative effects of attitudes. The long term effects of computer anxiety have not been established through research. However, since the majority of researchers agree that high levels of computer anxiety are undesirable, thus it is concluded that reduction of computer anxiety is desirable. Very little research has been reported that examines reduction of computer anxiety.

Most of the few studies that do examine reduction of computer anxiety tend to use a computer literacy class as the treatment to reduce anxiety (Honeyman & White, 1987;

Mackowaik, 1988; Koohang, 1987; Lambert, Lewis & Lenthall, 1989b; Bartelle, 1988). These studies used existing courses (i.e., computer literacy classes) and examined their effect on computer anxiety. Manipulated treatments of computer anxiety, that is, studies that had specifically designed treatments for the purpose of reducing computer anxiety, were reported rarely in the literature (Lamb, 1984; Bloom & Hautaluoma, 1990; Rosen et al., 1989). Research relating to treatment of other sorts of anxieties were not so rare however.

In clinical psychology, computer anxiety would be classified as a simple phobia. "Simple phobias, often referred to as specific phobias, are characterized by four central features: (1) a persistent and irrational fear of an object or situation, (2) a compelling desire to avoid the object or situation, (3) significant distress arising from the disturbance, and (4) recognition by the individual that his or her fear is unreasonable" (Last, 1987, p. 176). This definition closely matches the definition that was developed for computer anxiety.

The treatments most commonly described for the reduction of simple phobias include systematic desensitization, relaxation training, and cognitive restructuring (Last, 1987; Kleinknecht, 1986). The treatments described are usually administered over an extended period of time. It is felt that the findings of researchers in this area can likely be applied to the problem of reducing computer anxiety.

A review of research dealing with computer anxiety indicates that two statements can be made: 1) there is strong evidence supporting the existence of the construct of computer anxiety, and 2) little is known about effective methods for reducing computer anxiety.

Need for the Study

> The Revolution manifest in this new age - this age of intelligent machines - is in its earliest stages. The impact of these new machines that augment our mental resources will be greater than the radical technological and social changes that have come before. It cannot be stopped. Today's challenges are to be found in our need to understand it, to learn to live creatively and harmoniously with it and to harness it to constructive uses. (Kurzweil, 1986, p. 58)

Computers have come to play a very important role in today's society, particularly in education where their use has steadily been increasing (Becker, 1990). The literature strongly supports the existence of the construct of computer anxiety. Further, several researchers have concluded that there is likely to be a significant negative consequence of having high levels of computer anxiety. It has been estimated that high levels of anxiety relating to computers exists in a large proportion of the population. Weil, Rosen and Sears estimated that "as many as one out of three adults suffers from aversive reactions to computers and computer-related technology" and that these reactions range from "mild discomfort to severe debilitation" (1987, p. 180). Together, these conclusions combine to emphasize the importance for identifying and developing methods for reducing computer anxiety.

The most effective treatment of anxiety is unknown at this time, and in addition, there is some indication that it is possible that no single treatment is best even for a single specific type of anxiety. In discussing treatment of morbid anxiety states, Sartorius pointed out that "the frequency and ubiquity of morbid anxiety states and their influence on human life have led to an effort to develop a treatment that will be efficacious, simple without risks, and inexpensive. As yet, no such treatment has been found. A variety of methods of treatment have been proposed, and each of them seems to help some people but not others" (Sartorius et al., 1990). In reviewing the anxiety treatment literature more closely related to computer anxiety, namely simple phobias (which would include computer anxiety), Stugis and Scott stated "the authors must conclude that it is presently unclear which treatment procedure is most effective with each of the simple phobias" (1984, p. 133). They go on to state "the most salient variable may actually be self-exposure, and the most efficacious treatment procedure may be whichever one is the most persuasive in getting the client to expose him or herself to the feared stimulus" (Sturgis & Scott, 1984, p. 134).

Because of the lack of certainty about the most effective treatment of computer anxiety, it is important to learn more about the effect of different treatment strategies on different groups of individuals. It is likely that different treatments will have significantly different levels of success with different types of people. For example, one treatment may be more effective for men while another treatment would be more effective for women. The relationship of personality variables (e.g., extroversion, locus of control, hemisphericity) and demographic variables (e.g., gender, previous computer experience, age) to reduction of computer anxiety must be explored to determine what sorts of treatments for reducing computer anxiety are most effective for what sorts of people.

Statement of the Problem

The primary purpose of this study was to examine possible approaches for reducing computer anxiety. The approaches examined were participation in a semester long introductory computer course for education majors (hereafter reffered to as computer literacy training), and relaxation training in conjunction with participation in this course. These methods were selected because it was believed that of all generally accepted methods of reducing anxiety identified in the literature that might be applied to computer anxiety, these could be most easily integrated into the existing classroom environment.

A secondary purpose of this study was to examine personality and demographic variables that interact with these treatments. Previous computer literacy experience of the study's subjects, and the personality variable "need for cognition" were also examined.

The final purpose of this study was to examine the relationships between of computer anxiety and achievement in the course. Achievement in the course was separated into two parts; achievement in the lecture portion of the course, and achievement in the lab portion of the course. The effect of relaxation training on achievement was also of concern, as was the relationship between course achievement and change in computer anxiety from the beginning to the end of the course.

Research Hypotheses

In order to achieve the purpose of this study, the following 12 hypotheses were tested:

1) Students with previous computer literacy training have significantly lower precourse computer anxiety than those with no previous computer literacy training.
2) The computer anxiety of students involved in a semester long computer literacy course will be significantly lower after the course than it was at the beginning of the course.
3) The computer anxiety of students after the first six weeks of a computer literacy course is not significantly different from their computer anxiety at the beginning of the course.
4) The change in computer anxiety of participants in a semester long computer literacy course is different for students with previous computer literacy training than for those without previous computer literacy training.
5) Students who participate in a semester long relaxation training program in conjunction with a computer literacy course will have significantly lower postcourse computer anxiety than students who participate in the computer literacy course without the relaxation exercises.
6) There is a significant negative relationship between precourse computer anxiety and the personality variable, need for cognition, for participants in a semester long computer literacy course.
7) There is a significant relationship between "need for cognition" and reduction of computer anxiety for participants in a semester long computer literacy course.

8) There is a significant negative relationship between precourse computer anxiety and final grade in a computer literacy course.
9) There is a significant negative relationship between postcourse computer anxiety and final grade in a computer literacy course.
10) The relationship between postcourse computer anxiety and grade in a computer literacy course will be significantly stronger than the relationship between precourse computer anxiety and final grade.
11) The relationship between change in computer anxiety and course achievement is greater in the lab portion (hands-on assessment of achievement) than in the lecture portion (paper and pencil assessment of achievement) of a semester long computer literacy course.
12) Participants in relaxation training have significantly higher grades in the lab portion of a computer literacy course than the control group, but do not have significantly higher grades in the lecture portion of the course.

Basic Assumptions

Computer anxiety was assessed in this study using the Computer Anxiety Index (CAIN, Maurer, 1983). The need for cognition was assessed using the Need for Cognition Scale (NCS, Cacioppo & Petty, 1982). The achievement grades were supplied by the course instructors.

The basic assumptions of the study were:

1) All measures were reliable and valid.
2) Individuals responded to the items on the CAIN and the NCS in a truthful and unbiased manner.

3) Random assignment of individuals to relaxation and control groups was effective in producing groups that were identical in any aspects that might effect computer anxiety, reduction of computer anxiety, or achievement in the course.
4) Individuals involved in the relaxation exercises were more physically relaxed after the exercise.
5) The placebo procedures used by the control group had no effect on computer anxiety or achievement in the course.
6) Participation in the computer literacy course was the most important exposure subjects had to computers during the course of the study.
7) The subject population had a lower average CAIN score than the population of education majors, because they were voluntary participants in a computer literacy course.

Limitations of the Study

This study had the following limitations to the generalizability of results of this study:

1) The subjects were primarily students involved in an education curriculum and who elected to take a computer literacy class.
2) The subject population was predominantly female.
3) Subjects in the course were voluntary participants in the study, and it is not known how those who elected not to participate might have differed from those who did participate.
4) Results other than those related to the relaxation treatment were derived using a nonexperimental design.

Summary

It has become accepted in the literature that the phenomenon called computer anxiety is a real and measurable construct. A small amount of information about this construct is available in the literature. A significantly weak area in the research literature relates to reduction of computer anxiety. This study was proposed and conducted to strengthen the information that is available about the reduction of computer anxiety.

LITERATURE REVIEW

> Many people avoid the computer or use it with great anxiety; they suffer from "computer shock", "terminal terror", or "network neurosis". Their anxieties include the fear of breaking the machine, worry over losing control to the computer, trepidation about appearing foolish or incompetent ("computers make you feel so dumb"), or the common concern about something new. These anxieties are real, should be acknowledged rather than dismissed, and can often be overcome with positive experiences" (Scneiderman, 1989).

Introduction

This chapter will contain five major sections. The first section will contain a brief review of literature related to anxiety and anxiety reduction. This information is the foundation for other sections in this literature review. The second section will provide background information about computer anxiety. This section will include information about measurement practices and techniques in common use, what is known about, and what relates to the phenomenon of computer anxiety, and the relationship of math anxiety and test anxiety to computer anxiety. The third section will examine computer anxiety reduction strategies that have been reported, including those strategies that used either relaxation techniques, instructional techniques, or both. The fourth section of the chapter will synthesize the information in the previous sections dealing with computer anxiety correlates and anxiety reduction strategies. The last section will summarize the previous sections.

Anxiety and Anxiety Reduction

Definition of Computer Anxiety

In the field of clinical psychology, computer anxiety would be classified as a simple phobia. "Simple phobias, often referred to as specific phobias, are characterized by four central features: (1) a persistent and irrational fear of an object or situation, (2) a compelling desire to avoid the object or situation, (3) significant distress arising from the disturbance, and (4) recognition by the individual that his or her fear is unreasonable" (Last, 1987, p. 176). Simple phobias include fear of snakes, rats, spiders, heights, and enclosed spaces. Simple phobias are distinguished from other anxiety disorders such as agoraphobia (a cluster of fears relating to being away from a safe place), social phobias (fears relating to social interaction), obsessive-compulsive disorder, mixed anxiety/depression syndrome, and stress disorders (Sartorius et al., 1990). The definition of a simple phobia is consistent with several that have been proposed relative to computer anxiety (Maurer, 1983; Raub, 1984; Rosen, Sears & Weil, 1987).

Clinical Anxiety Reduction

To those interested in reducing computer anxiety, one rich source of information is the field of clinical psychology. However, this study focuses on reduction of computer anxiety in an instructional setting. Therefore, in drawing from clinical psychology, it must be remembered that psychotherapy should be carried out by those who are trained in that field, not by teachers. What can be "taken" from the field of clinical psychology, and applied to an instructional setting, must be considered with this in mind.

The following is an overview of the current thinking and practice in the field of clinical psychology on the problem of treatment of simple phobias. Kleinknecht states that "some of the most effective psychological procedures used for treating anxiety disorders [are] generically referred to as *Behavior Therapy*" (1986, p. 154). He goes on to describe treatment procedures. "The treatment procedures to be described are all aimed at uncoupling the ties between situations and the automatic fear or anxiety responses. These procedures attempt to accomplish this uncoupling by focusing on changing three main response components. Although the several procedures have the same goal of reducing the anxiety or fear, they have different emphases. Some focus on attempting directly to reduce the physiological component by training in relaxation. Others focus first on eliminating the avoidance component by ensuring that the individual is exposed to the anxiety-provoking situation without escaping. Other approaches focus on the cognitive component. These approaches attempt to restructure or change anxiety-provoking thought and self-statements." Kleinknecht goes on to describe each of the three (Systematic Desensitization, Exposure Treatments, and Cognitive Restructuring) approaches. Several experts in the field agree that of these three well accepted behavioral treatments for simple phobias, none has been shown to be more effective than the other in reducing anxiety (Barlow, 1988). Systematic desensitizaton will be focused on in this study, because it is believed that these procedures are most in concert with the sorts of activities that would occur in a classroom. Exposure treatments, and cognitive restructuring would be more in the domain of clinical psychology.

Thyer points out that "a series of well controlled group studies also supported the efficacy of systematic desensitization in the treatment of simple and social phobias" (1987, p. 41). Kleinknecht makes the same point; "Systematic desensitization has been validated in literally hundreds of experimental investigations. Although evidence of effectiveness has been demonstrated for almost all anxiety disorders, it appears to be most fruitfully applied to the phobias" (1986, p. 155). Since computer anxiety can best be classified as a simple phobia, it would be reasonable to assume that systematic desensitization would be an effective treatment.

Kleinknecht points out that it has been theorized that many anxiety responses, such as those related to computers, have been developed through a classical conditioning process, and that to cure the problem, the link between the stimulus and the anxiety response must be broken. The goal of systematic desensitization is to break that link, say between heights and a panic response, or computers and avoidance.

Kleinknecht further describes clinical systematic desensitization processes as occurring in three phases, 1) Relaxation Training, 2) Anxiety Hierarchy, and 3) Desensitization Procedure. The goal of relaxation training is to teach the subject to physically relax their muscles. Kleinknect states that "there are many effective ways to attain a state of relaxation and for the purpose of Systematic Desensitization it makes little difference which is used" (1986, p. 156).

The anxiety hierarchy, as described by Kleinknecht, is the process of creating a gradiated list of situations that increase levels of anxious arousal. This list is developed by an individual, and is specific to them. The items on the list should represent a gradual increase in anxious arousal, from a low level of anxiety to a high level.

The final step in the systematic desensitization process is called the desensitization procedure. Kleinknecht gives an example of this process by describing treatment for fear of dentists.

> The task is to enable the person to imagine the anxiety-provoking situations from the hierarchy while maintaining relaxation. This is accomplished by first having the subjects deeply relax. Then the therapist begins by presenting the least anxiety-provoking scene from the hierarchy for the subject to imagine. For example, from the hierarchy in Table 5.1 it might be "Imagine opening a magazine and seeing the word 'dentist'." If the person then experiences any anxiety, he or she is instructed to signal the therapist, usually by raising a finger. At the signal of felt anxiety the subject is instructed to stop imagining the word "dentist" and attempt to regain the full state of relaxation. Usually, a neutral or very pleasant scene, determined in advance, such as lying on the beach in the warm sun, is used at this point to facilitate relaxing and to give the subject something peaceful to think about. Once relaxation is regained, the anxiety scene is presented again. Each successive presentation typically results in a reduction in anxiety until the subject is able to remain completely relaxed while visualizing the scene. At this point, the second item is presented and the process is repeated for each item until the subject masters the entire hierarchy with no signs of anxiety (Kleinknecht, 1986 p. 158).

In terms of procedures, Kleinknecht points out that many variations of systematic desensitization have been shown to be effective. Further, he states "systematic desensitization was also noted to be effective when conducted in groups and when automated by the use of tape-recorded presentations of the procedure" (1986, p. 190).

Kleinknecht concludes by stating that the important issue in this process is that subjects generalize their lack of anxiety response to the real situation (versus the imagined situation). "This carryover or response generalization does indeed occur" (1986 p. 159). Kleinknecht's clear implication here is that generalization is automatic if it is attempted, and constitutes an almost trivial component of the process.

Thyer describes the same basic process as the most accepted clinical remedy for simple or social phobias, although he gives slightly different names to its three steps. He also expands on the information given by Kleinknecht by pointing out that there is some concern about the theoretical basis of the procedure. This concern has sparked significant research in the area, and he states that current research has found that "(1) Systematic desensitization conducted exclusively in imagination is decidedly inferior to systematic desensitization conducted with concurrent real-life homework practice; and (2) real-life exposure *alone* is an exceptionally effective treatment for phobias in and of itself" (1987, p. 41). Thyer concludes these remarks by saying "the status of empirical research at the present time indicates that real-life exposure therapy is the treatment of choice for most clients with simple or social phobias" (1987, p. 41).

Last's (1987) procedures for the treatment of simple phobias concentrate on cognitive and cognitive/behavioral treatment strategies. She states that the majority of the cognitively based treatments "may be subsumed under the category of 'cognitive-restructuring' since they all attempt to modify directly specific thoughts and beliefs believed to be mediators of arousal" (1987, p. 180-181). The process is described as follows: "[it] generally includes presentation of the rational-emotive therapy rationale (i.e., that irrational thoughts play an important role in subjective distress); monitoring of thought patterns so that clients can become aware of their irrational self-verbalizations and the situations in which they are likely to be elicited; and developing more adaptive thought patterns. In addition, clients are usually assigned *in vivo* homework assignments in order to have practice using these newly acquired cognitions" (p. 181).

A second approach outlined by Last is called self-instructional training. "In this approach, self-verbalization or 'self-talk' is viewed as the precipitant for a wide range of emotional and behavioral disorders. In the case of anxiety reactions, the aim of treatment is to have clients become aware of their negative or irrational thought patterns when anticipating or confronting an anxiety-producing situation, and to change these thoughts by substituting more adaptive, coping self-statements" (p. 181).

Last concludes with a synthesis of the literature reporting, empirical studies that examined the effectiveness of cognitive techniques. Her conclusions was that cognitive interventions had been shown to be effective with fearful subjects (less anxious), but not effective with "clinical phobias" (more anxious). Further, when comparing cognitive treatment with *in vivo* exposure, she concludes "it is clear that results are discrepant for merely fearful as opposed to truly phobic clients. Whereas the analogue investigations cited earlier tend to support the utility of cognitive restructuring with fearful populations, results from clinical investigations show purely cognitive interventions to be inferior to behavioral treatment (*in vivo* exposure) (Piran & Wilson, 1981), and to be of no additional therapeutic value when combined with behavioral techniques (Ladouceur, 1983)."

The literature of clinical psychology indicates that the most effective treatment of anxiety known today is *in vivo* exposure. In the case of computer anxiety, exposure to computers in an instructional setting would fit nicely into this category. To enhance this exposure, two techniques are suggested, systematic desensitization, and cognitive restructuring. Both of these procedures as practiced by clinical psychologists would probably be inappropriate for a classroom setting, but components of each could be used by teachers.

Computer Anxiety Background

Introduction

The study of computer anxiety is a relatively new area of investigation. It has its roots in "resistance to change" research done in the 1970's, and was operationalized in the early 80's by several researchers (Loyd & Gressard, 1984b; Maurer, 1983; Oeting, 1983; Rohner, 1982). As a result, much of the research that has been done in this area was exploratory, involving the development of measurement tools and techniques, and/or involving development of the construct of computer anxiety. Computer anxiety measures have been developed by a significant number of individuals (Cambre & Cook, 1987; Campbell & Perry, 1988; Dambrot, Watkins-Malek, Silling, Marshall, & Garver,1985; Issa & Lorentz, 1989; Loyd & Gressard, 1984b; Mackowiak, 1988; Marcoulides, 1989; Maurer, 1983; Rosen, Sears & Weil, 1987; Vredenburg, Flett, Krames, & Pliner 1984). As further development of the construct, a number of studies examined correlates to some operational measure of computer anxiety (e.g., Cambre & Cook, 1987; Collins, 1985; Gressard & Loyd, 1985; Honeyman & White, 1987; Koohang, 1987; Loyd & Gressard, 1984a; Loyd & Gressard, 1987; Raub, 1981; Mackowiak, 1988; Rosen, Sears & Weil, 1987; Sievert, Albritton, Roper & Clayton, 1988; Wallace, 1988). This sort of work comprises the bulk, but not all of the research that has been done in the area of computer anxiety.

Measurement Tools

Although the measurement of attitudes like computer anxiety is a somewhat difficult prospect, it has been recognized as possible for some time (Thurstone, 1928). There are two primary problems that are involved in the measurement of computer anxiety. The first relates to the clear definition of the construct that is being measured, and the second is the operationalization of that construct.

The problem of definition begins with the distinction between computer anxiety and computer attitudes. While some researchers clearly distinguish between them (e.g., Loyd & Gressard, 1984b; Maurer, 1983; Rosen, Sears & Weil, 1987), others use the terms interchangeably (e.g., Cambre & Cook, 1987; Dambrot, Watkins-Malek, Silling, Marshall, & Garver,1985). A less than clear definition of what is being measured gives research a very weak foundation.

A dictionary definition is one way to begin to make a distinction. Anxiety is a term that has a relatively clear definition, and is a concept that has a relatively common understanding in our culture. Merriam-Webster's definition is as follows: "1: Painful uneasiness of mind usu. over an anticipated ill 2: abnormal apprehension and fear often accompanied by physiological signs (as sweating and increased pulse), by doubt about the nature and reality of the threat itself and by self-doubt" (Woolf, 1974). The pertinent definition of the word attitude is as follows: "a mental position or feeling with regard to an object" (Woolf 1974). It is clear that the definition of anxiety is more specific than the definition of attitude, and it could also be claimed that anxiety could be considered a subset of attitude. The word attitude is further defined by the research community. Thomas and Znaniecki first defined attitudes as "a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (1918).

Anxiety is part of the attitudinal domain, and therefore computer anxiety is part of the domain of computer attitudes. The distinction between the terms makes it clear that the exact interchange of them is inappropriate. For the purpose of this study, computer anxiety will be defined as "the fear and apprehension felt by an individual when considering the implications of utilizing computer technology, or when actually using computer technology" (Maurer, 1983, p. 2). This definition has been used by the following researchers (Cambre & Cook, 1987; Dukes, Discenza & Couger, 1989; Honeyman & White, 1987; Lamb, 1984; Sievert, Albritton, Roper & Clayton 1988).

The second problem that must be dealt with by those studying computer anxiety is the measurement of the phenomenon. The first question to be answered is "can attitudes be measured at all?" This issue has long been debated, and at least one large segment of the research community believes that attitudes can be measured. A rationale for this view (although somewhat dated in its language) is given by Thurstone.

> An attitude is a complex affair which cannot be wholly described by any single numerical index. For the problem of measurement this statement is analogous to the observation that an ordinary table is a complex affair which cannot be wholly described by any single numerical index. So is a man such a complexity which cannot be wholly represented by a single index. Nevertheless we do not hesitate to say that we measure the table. The context usually implies what it is about the table that we propose to measure. We say without hesitation that we measure a man when we take some anthropometric measurements of him. The context may well imply without explicit declaration what aspect of the man we are measuring, his cephalic index, his height or weight or what not. Just in the same sense we shall say here that we are measuring attitudes. We shall state or imply by the context the aspect of people's attitudes that we are measuring. The point is that it is just as legitimate to say that we are measuring attitudes as it is to say that we are measuring tables or men (Thurstone, 1928, p. 530).

Many researchers have developed ad hoc measures of computer anxiety for the purpose of a single study (Cambre & Cook, 1987; Campbell & Perry, 1988; Dambrot, Watkins-Malek, Silling, Marshall, & Garver,1985; Issa & Lorentz, 1989; Mackowiak, 1988; Vredenburg, Flett, Krames, & Pliner 1984). This approach is problematic because generally there is a lack of validity and reliability information available for the measure. It can be argued that ad hoc measures may not really measure computer anxiety at all, thus threatening the validity of the entire research project. A second problem with using ad hoc measures is that it makes it difficult to compare the results from one measure to another, since each measure is likely measuring a somewhat different aspect of the phenomenon.

Any attitudinal measure must meet certain criteria (Rajecki, 1982). These include: 1) the measure must be carefully developed to include substantial reliability and validity information, 2) the measure be appropriate to the measurement task for which it is intended (e.g., not using a yard stick to measure a blood cell) and 3) the measure be accepted and used by those in the field to which it relates.

There are currently several measures of computer anxiety that meet some or all of these criteria. The two most widely used are the Computer Anxiety Index (CAIN; Maurer, 1983), and the Computer Attitude Scale (Loyd & Gressard, 1984). Other measures that have been developed and used by single researchers include the Computer Attitude Rating Scale (CARS; Rosen, Sears & Weil, 87), the Computer Anxiety Scale (Marcoulides, 1989) and the Computer Aversion Scale (CAVS; Meier, 1988). All of these measures are very similar in that they consist of a number of statements about computers and the subject responds to the items using a Likert scale.

The CAIN (Maurer, 1983) is a 26 item measure, containing statements about an individual's feelings about potential situations they would face when using computers. The respondent must agree or disagree with these statements using a six point scale. The CAIN produces a single value that purports to relate to the anxiety that is felt by the individual.

The CAIN has substantial reliability and validity information. The internal consistency was determined using Chronbach's alpha technique, and was found to be .96 ($r=.96$). The test/retest reliability of the measure was found to be .90 ($r=.90$). Concurrent validity information has also been collected for the CAIN. The CAIN was shown to significantly correlate to an observer's rating of anxious behavior while 111 subjects were using computers ($r=.36$, $P<.01$). The same 111 subjects were given the well known State Trait Anxiety Index (STAI, Spielberger, 1970) as they sat in front of computers, and just prior to beginning a lesson using computers. The correlation between these two measures was also significantly correlated ($r=.32$, Maurer, 1983, p. 43).

The Computer Attitude Scale (Loyd & Gressard, 84) is a 30 item measure that contains 3 subscales of 10 items each. The subscales are computer anxiety, computer liking, and computer confidence. The coefficient alpha for the anxiety subscale was found to be .86 (r=.86). The only other information provided for this measure that relates to its validity is a factor analysis that indicated that the 3 subscales appeared to measure different things.

The Computer Anxiety Scale (Marcoulides, 1989) is a 20 item test. The original pool of items were submitted to a panel of judges to assess face and content validity. Other validity information presented with this instrument consisted of a factor analysis. The author concluded from this analysis that the Computer Anxiety Scale "measures two specific factors: general computer anxiety, and equipment anxiety."

The CAVS (Meier, 1988) is a 31 item scale that contains three expectancy subscales: efficacy, outcome, and reinforcement expectations. The alpha coefficient for the scale was found to be .89 (r=.89), and was slightly lower for each subscale. The responses of 78 subjects to both the CAVS and the CARS (Rosen, Sears & Weil, 87) were correlated to give a concurrent validity coefficient of -.53 (r=-.53, p<.001, Meier, 1988, p. 180). Factor analyses on the three subscales "provide equivocal support for the three subscales of the CAVS. Evidence was found of overlap between the Efficacy Expectations and Outcome Expectations subscale items . . . ."

The CARS is a 54 item measure, containing items that describe situations that are encountered when using computers. Respondents indicate how anxious each statement makes them feel. This measure was found to have a high level of internal consistency. Coefficient alpha was .97 (r = .97). Further, the authors state that the internal structure is "respectable" based on the results of a factor analysis. Test/retest reliability was found to be .62 using a sample of 145 subjects.

Another method used to measure computer anxiety has been reported. Honeyman and White (1987) used the state portion of the State-Trait Anxiety Index (Spielberger, Gorsuch, & Lushene, 1970) while subjects were involved with interaction with computers. It can be argued that this measure, used as an indication of computer anxiety could be confounded with other sorts of anxieties that are not directly related to computers (e.g., fear of being in a room full of people). There are also concerns with this approach in terms of the sensitivity of the instrument for the purpose of measuring computer anxiety.

Studies that have looked at interrelations between these (and other) measures have given additional information about the measurement of computer anxiety. As mentioned above, Meier correlated the CAVS with the CARS, and found a correlation coefficient of .53 (r=.53). Although this value was statistically significant, and an indication that there was a relationship, the strength of that relationship was not as strong as might be expected. The two measures claimed to measure the same phenomenon or at least a very closely related constructs. The CAVS measured computer aversion, and the CARS measured computer anxiety. The correlation between the two should be much higher. "Correlation coefficients over .85 indicate a very close relationship between two variables correlated" (Borg & Gall, 1989, p. 632).

Other measures of computer anxiety have been developed (e.g., Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Erickson, 1987; Raub, 1981). These and other ad hoc measures will not be reviewed in further detail here because of the almost complete lack of reliability and validity information available for them.

Two studies were found that attempted to examine the interrelationship between computer anxiety scales. Dukes, Discenza and Couger (1989) looked specifically at four computer anxiety scales, and their relationships with each other. The four scales they examined were the CAIN (Maurer, 1983), the Attitude Toward Computers (ATC) scale

(Raub 1981), the Computer Attitude Scale (misidentified in the article as the Computer Anxiety Scale; Loyd & Gressard, 1984) and the Blomberg-Erickson-Lowery Computer Attitude Task (BELCAT, Erickson, 1987). One of these measures dealt specifically with computer anxiety, and the other three each had an anxiety subscale. The method used by Dukes et. al. was to combine the 4 measures into a single instrument, and deliver it to a group of 221 undergraduate students. One problem that was evident with this methodology that was not mentioned by the authors was that the 4 instruments did not all use the same response sets. The Computer Attitude Scale, the ACT, and the BELCAT all used a 5 point scale, and the CAIN used a 6 point scale. It can be inferred from the information in the article that they resolved this problem by using a 5 point scale for all four measures. These researchers found very high coefficients of internal consistency for each measure, ranging from .84 (r=.84) to .96 (r=.96).

Also of interest was the intercorrelations between the measures (see Table 1). This information led the authors to conclude "the instruments showed a high degree of interrelation across all four scales, thus supporting the notion that computer anxiety is a very robust concept, and its various operational definitions exhibit a high degree of convergent validity (Dukes, Discenza & Couger, 1989, p. 202).

Kernan and Howard (1990) also analyzed several computer attitude and anxiety measures. They compared the results from Dambrot's Computer Attitude Scale (CATT; Dambrot, Watkins-Malek, Silling, Marshall & Garver, 1985), the Attitudes Toward Using Computers Scale (ATCUS; Popovich, Hyde, Zadrajsek, & Blumer, 1987) and Raub's Computer Anxiety Scale (Raub, 1981). To these three measures, they added four items relating to alienation and four items suggested by Morrison's Attitudes Toward Computers Scale (Morrison, 1983), "which, together, represented the view of computers as awesome and astonishing machines" (Kernan & Howard, 1990, p. 683).

Kernan and Howard (1990) combined the items, split them in half, and had the first half of the combined test completed by 335 subjects enrolled in an introductory computer class. It is important to note that the administration of these measures was at the beginning of the course. The second half of the test was completed a week later by the same subjects. A retest of the total test was given 12 weeks later to 50 subjects who were in the original sample and who were paid to take the retest. In addition, all subjects completed the State Trait Anxiety Index (STAI) (Spielberger, Gorsuch, & Lushene, 1970), a math attitude scale (Fennema & Sherman, 1976), and self report items relating to expected course grade, liking of the course, skill level at the end of the course, and prior experience with computers. Analysis of this information consisted of a factor analysis of the combined computer attitude and anxiety items, along with correlations of several pairs of variables.

The factor analysis identified five factors. Factor one related to computer anxiety, and the other four related to computer attitudes. The computer anxiety factor was composed primarily of items from Raub's Computer Anxiety Scale (Raub, 1981). This factor was significantly correlated with state anxiety (r=.31), math anxiety (r=.23) and trait anxiety (r=.34). None of the other four factors correlated any higher than .16 (r=.16) with any of these variables. The internal consistency (as measured by the split test with a week intervening) of factor one was .92 (r=.92), and the test-retest (12 weeks later) reliability was .69 (r=.69). The reliability estimates for all the other factors were significantly lower than those for factor 1. The explanation for the relatively low test-retest correlations was given by Kernan and Howard is as follows: "Since 12 weeks elapsed between questionaire administrations, the instability of factor scores over time may have been due to real anxiety and attitude changes as a function of course learning." (1990, p. 688). The retest anxiety score was lower, and a t-test between the test and retest showed the change to be statistically significant. For a small sample of subjects (N=35) who were not enrolled in a computer course, the same test-retest correlations for factor 1 were found to be much higher (r=.91).

The findings of this study lend significant support to the belief in the existence of the construct of computer anxiety (Kernan & Howard, 1990). The high reliability figures, along with the strong relation to general anxiety, and math anxiety, were interpretted as further indications of validity of the construct. Support for the idea that computer anxiety was a separate construct, different than math anxiety or general anxiety was provided by the fact that the correlations between computer anxiety, math anxiety and general anxiety were not extremely high. Also, the fact that the four attitude measures did not correlate significantly with general anxiety or math anxiety lends support to the idea that computer anxiety is separate and distinct from other computer attitudes.

One final interesting finding reported in this study related to class grade and course withdrawal behavior (drop out). "Somewhat surprisingly, neither anxiety or any of the four attitudinal factors were able to predict course grades or withdrawal behavior" (Kernan & Howard, 1990, p. 689).

Kernan and Howard concluded by suggesting that computer experience may be significant in producing change in computer anxiety. "The significant reduction in computer anxiety (Factor 1) and one of the attitude factors (Factor 5) found here, suggests that interactions with the computer itself, especially over a 12-13 week period, may change one's view of computers, making it difficult to isolate reliable predictors."

Although this study represents some of the most careful work in the area of measurement of computer anxiety and attitudes, there is one criticism that must be made. It did not review all of the best instruments that were available (e.g., Loyd & Gressard 1984b; Maurer, 1983; Rosen, Sears & Weil, 1987).

The most significant problem with most of the computer anxiety measures that are currently being used is the lack of reliability and validity information about them. As the previous descriptions illustrate, the most common development approach has been to look only at internal consistency. Only two of the measures reviewed here have any form of validity information that is external to the measure itself: the CAIN (Maurer, 1983) and the CAVS (Meier, 1985). Of these two measures, the CAVS lacks any test/retest reliability information. The CAIN, having the most complete reliability and validity information, will be used as the measure of computer anxiety in this study.

Knowledge about Computer Anxiety

What is known about computer anxiety is not substantial. The bulk of the studies in the area have looked at correlates to computer anxiety. The majority of these studies have examined age, gender, and past computer experience. A few studies have reported information other demographics such as academic major, several have looked at achievement in a computer course as it related to computer anxiety, and others have looked at personality variables such as locus of control. Finally, a handful of studies have examined the relationship between other types of anxiety and computer anxiety (e.g., math anxiety, state anxiety).

There seems to be little synthesis of information about computer anxiety taking place. In fact, the same information prompted different researchers to form diametrically opposing conclusions about the most fruitful approach to the remediation of computer anxiety. The most significant area of disagreement is in answer to the question "does computer experience reduce computer anxiety?" One group of researchers have stated that exposure to computers is insufficient to reduce computer anxiety, and could even be detrimental (Weil, Rosen, & Sears 1987) while others have indicated that exposure is the primary concern for reducing computer anxiety (Honeyman & White, 1987; Koohang, 1987; Mackowiak, 1988) Weil, Rosen and Sears stated "One reason computerphobia has been generally ignored to date is the misconception that experience alone is sufficient to 'cure' the problem."

On the other side of the argument there are a group of studies involving instruction and computer exposure that concluded that experience was the primary means by which computer anxiety was reduced. Honeyman and White concluded that "without adequate time in contact with the computer these states of anxiety will not become lower and the beginner's fear of computers will continue." Mackowaik (1988) stated that "hands-on experience with computers is needed to generate more favorable attitudes." In a study that used preservice teachers as subjects, Koohang (1987) recommended that "computer experience be provided for pre-service teachers . . . ." Lambert, Lewis and Lenthall (1989b) concluded that "increased exposure to computers is likely to assist in the reduction of computer anxiety" (p. 7). In a study that used secondary school principals as subjects, Bartelle (1988) concluded that "secondary principals can reduce levels of computer anxiety by increasing their interaction with the keyboard, as well as by becoming more involved in other computer experiences" (p. 2).

There are three problems with these and many other studies that recommended, or suggested that experience would reduce computer anxiety. First, very few of these studies manipulated the experience variable, but drew conclusions on the basis of a strong correlation between computer anxiety and computer experience. Naturally, the anxiety could have caused the experience, the experience could have caused the anxiety, or some third factor could have been responsible for their relationship (Borg & Gall, 1989).

The second problem with most of the studies that concluded that experience was important to the reduction of computer anxiety was that most of them lacked control groups. As a result, they did not rule out a number of other possible alternative explanations for the change in anxiety scores (e.g., subject maturation). The use of control groups would have strengthened their conclusions.

A third problem is one of generalization of this research. Most of the research involved the use of subjects in elective courses. Two studies suggested that individuals who self-selected into computer classes had significantly more positive computer attitudes than those who did not (Hill, 1988; Slowiczek, 1988). If this is true, it is likely that the population that was in most need of anxiety reduction was not addressed by the bulk of the research.

One study that did use a control group was reported by Lamb (1987). She found that subjects who used a computer-based instruction (CBI) lesson had significantly lower computer anxiety than the control group that did not use the computer. Further, Lamb found that the computer anxiety of the CBI group increased, over the following two weeks. This finding led Lamb to conclude "one explanation for this increase in anxiety could be because of the direct computer experience these groups received. Because they completed the questionaire immediately after computer use, their anxiety could have been momentarily reduced." If this finding could be replicated, it would lend significant weight to the proposal that computer experience reduced computer anxiety. It also suggests that there may be some "recency of experience" effect related to computer anxiety.

On the subject of gender relationships to computer anxiety, a number of studies found that females were more computer anxious than males (Cambre & Cook, 1987; Collins, 1985; Gressard & Loyd, 1985; Koohang, 1987; Loyd & Gressard, 1987; Raub, 1981;) and a number of studies found no gender differences (Honeyman & White, 1987; Loyd & Gressard, 1984; Mackowiak, 1988; Sievert, Albritton, Roper & Clayton, 1988; Wallace, 1988). The studies that supported the correlation between gender and computer anxiety are problematic because other research found that prior experience of males with computers is greater (Levin & Gordon, 1989; Vredenburg, Flett, Krames, & Pliner, 1984) and that access to computers by males was greater (i.e., parents tended to provide computers for male children more than for female children) (Campbell, 1989; Eaton, Schubert, Dubois, & Welman, 1985). Research that reported a relationship between computer anxiety and gender should probably have controlled for the experience level and as a matter of fact, one study that added availability of a computer in the home as a covariate found no difference in the level of computer anxiety between the genders (Campbell, 1989).

Rosen, Sears and Weil (1987) attempted to examine this apparent contradiction by looking at "culturally induced sex-role differences." They found that gender "role" (as measured by the Bem Sex Role Inventory; Bem, 1974) tended to have a stronger correlation to computer anxiety than did gender, with feminine-identity subjects having more computer anxiety than masculine-identity subjects. They also found that the experience variable was strongly related to the role identity, with feminine-identity subjects having had significantly less experience.

As with gender, the question of the relationship of age to computer anxiety is not straight-forward. Many studies that examined age used typical student populations that had a relatively narrow age range. In general, those studies that had subjects with a wider age range tended to report an age effect, with younger subjects being less anxious (Cambre & Cook, 1987, Francis, 1988; Rosen, Sears & Weil, 1987). Conversely, those studies with narrow age range samples tended to report no effect for age (Loyd & Gressard, 1984a). These findings were not consistent, however. Some studies with relatively wide age ranges reported no effect due to age (Kuhn, 1989; Sievert, Albritton, Roper & Clayton, 1988). None of these studies controlled for the experience level of their subjects.

Three studies were found that examined the relationship between academic major and computer anxiety for college students (Griswold, 1985; Lamb, 1984; Rosen, Sears & Weil, 1987). Griswold (1985) reported that business majors had significantly lower anxiety than education majors. Rosen, Sears and Weil (1987) found, when comparing "general students" with "computer and business students", that the general students had significantly higher computer anxiety than computer and business students. In a study of preservice teachers, Lamb (1984) found differences in computer anxiety scores based on the students academic area of specialization. Lamb did not report any information on the statistical significance of these differences.

Studies that have examined achievement (as measured by course grade) in relation to computer anxiety typically involved enrollment in a computer class, but in a few cases, other classes were examined. Again, the findings were mixed. Two studies reported that precourse anxiety did not relate to course grade. Kernan and Howard (1990) found no correlation between precourse anxiety and course grade in students in a beginning computer course. Munger and Loyd (1989) found no relationship between computer anxiety and course grade for students in a summer enrichment mathematics class for high school students.

Another group of studies reported that computer anxiety was significantly related to achievement, with lower anxiety being associated with higher achievement. Marcoulides (1988) found a significant relationship between achievement and computer anxiety. In addition, he stated "as expected, experience was also an important factor in predicting achievement but not as important as computer anxiety." In a study dealing with the relationship between computer attitudes and the knowledge of computer ethics, Bear (1990) concluded, "results suggest that attitude toward computers may exert an important influence on a student's attention to and retention of information about computer-related ethical issues" (p. 84). In a study of computer science students, Hayek and Stephens (1989) concluded that "achievement in computer science courses was inversely related to computer anxiety.

Because of this inverse relationship, factors which reduce computer anxiety are very much of interest."

The last group of correlates that have been investigated can be grouped into a category called personality variables. Examples of personality variables could include introversion/extroversion, level of aggressiveness, brain hemisphere dominance, locus of control and level of general anxiety. This group of studies is small, but important, because further investigation of the relationship of personality to computer anxiety may give significant information to those who are attempting to reduce computer anxiety. The question that should be answered is "what techniques will work for what kind of personality?" Knowing more about the correlation of computer anxiety to various personality variables is the first step in answering this question.

Rohner (1981) examined two variables that are related to cognitive style, brain hemisphere dominance and field dependence. He found a weak relationship between computer anxiety and hemisphericity, with left brain dominant subjects tending to be slightly more computer anxious than right brain dominant subjects. He found no significant anxiety difference between field dependent and field independent individuals.

Hawk (1989) investigated the relationship between locus of control and computer attitudes. Hawk describes locus of control by paraphrasing Rotter (1966), as follows:

> Locus of control refers to the belief held by an individual regarding the cause-effect relationship between personal actions and positive and/or negative events. Internal-control individuals believe that positive and/or negative events depend on one's own actions and therefore are under personal control. External-control individuals believe that positive and/or negative events are under the control of powerful others, luck, fate, etc., and are therefore beyond personal control." (Hawk, 1989, p. 199).

This study took place in a business setting and it was found that there was no difference between "internals" and "externals" with respect to computer attitudes. However, if a third variable, level of involvement, was taken into account, differences were seen. Of those heavily involved with computers, locus of control had no relationship to computer attitudes. However, of those with a more casual involvement with computers, internal-control subjects had a significantly more negative attitudes than external-control subjects. One limitation of this study was that computer attitudes were measured using "information satisfaction." The self report instrument that was used measured the degree to which computer users viewed computer systems as being useful. This method of measuring computer attitudes was a departure from the rest of the research in this area.

Griswold (1985) also looked at the personality variable of Locus of Control. He compared this measure to an ad hoc measure of computer attitudes. This ad hoc measure was "a 20 item questionnaire addressing applications and social implications of computer technology" (p. 133). He found a significant relationship between these two variables ($r=.24$). In contradiction to the Hawk study (1989), "externals tended to have less favorable attitudes about computers" (p. 135). This contradiction could be explained by the difference in the measures used to identify computer attitude. Hawks operationalized computer attitudes as application oriented only, while Griswold also considered social implications as part of computer attitudes.

One final study examined the relationship of Holland type (Belando & Winer, 1985) to computer anxiety (Belando & Winer, 1985). Holland type was proposed by Holland (1973) as a system for classifying individuals according to vocational preference. The Vocational Preference Inventory (Holland, 1978) was used to measure Holland type. The "types" identified by this measure include: realistic, investigative, artistic, social, enterprising and conventional.

Belando and Winer found that the artistic and social types had significantly higher computer anxiety scores than the realistic, investigative, enterprising and conventional types. This would seem to contradict the hemisphericity results reported by Rohner (1981). Rohner found left brain dominant individuals to be slightly more computer anxious than right brain dominant individuals. Left brain individuals would tend to be more analytically, sequentially oriented, while right brain individuals would tend to be more wholisticly and intuitively oriented (Lutz, 1978). Although these two measures are quite different, a broad generalization about the results would seem to indicate a contradiction.

Personality information is important to the study of computer anxiety, because it could potentially play a significant role in guiding future research. In addition, information about the relationship between computer anxiety and various aspects of personality could have a significant effect on efforts to reduce computer anxiety. However, the information currently available relating personality variables to computer anxiety is limited. It is also not terribly useful in giving guidance for those interested in reducing computer anxiety at this point because few useful generalizations can be drawn from what is currently known. No clear research or practice oriented agenda can be developed from what is currently known about the relationship of computer anxiety to personality variables.

Relation of Math Ability and Math Anxiety to Computer Anxiety

Several researchers have looked at the relationship of math anxiety to computer anxiety (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Gressard & Loyd, 1984; Kernan & Howard, 1990; Marcoulides, 1988; Munger & Loyd, 1989; Rosen, Sears & Weil, 1987). The most common approach used was to compare math anxiety scores to computer anxiety scores. This was because of the hypothesized close relationship between the two simple phobias.

Dambrot, Watkins-Malek, Silling, Marshall, and Garver (1985) compared the Fennema-Sherman Math Anxiety Scale (Fennema, & Sherman, 1976) to an ad hoc measure of computer attitude in a study using 944 college students. They also examined math experience as measured by the previous number of specific types of math courses and math aptitude as measured by math ACT score. They found small but significant relationships between each of the math measures and computer attitude, with the strongest relationship between math anxiety and computer attitude (r=.24).

Kernan and Howard (1990) compared the Fennema-Sherman Math Anxiety Scale to a computer anxiety measure that was an amalgam of several existing measures. They found a significant relationship between these two measures of anxiety (r=.23) that was consistent with the findings of Dambrot, Watkins-Malek, Silling, Marshall, and Garver (1985).

Rosen, Sears and Weil (1987) compared the Mathematics Anxiety Rating Scale (MARS; Richardson & Suinn, 1972), to a measure of computer anxiety developed by the authors called the Computer Anxiety Rating Scale (CARS), that "was designed along the lines of the MARS." The relationship between the CARS and the MARS was stronger than what had been reported in previous studies (r=.33). This was not surprising since the CARS was developed using the MARS as a model.

Gressard and Loyd compared the Computer Attitude Scale (Loyd & Gressard, 1984b), which contained a computer anxiety subscale, to a modified version of the Fennema-Sherman scale. They found a relationship between computer anxiety and math anxiety (r=.39). In attempting to predict computer anxiety from computer experience, math anxiety and gender, Gressard and Loyd reported that computer experience was a strong predictor, math anxiety a weak predictor, and gender was not a significant predictor of computer anxiety.

Marcoulides (1988) compared the MARS to his own Computer Anxiety Scale. He found a relationship that was consistent with the findings of previous research (r=.28). Marcoulides also used a stepwise regression technique to with computer achievement (grade in a required computer information systems course) as the criterion variable. He used computer anxiety, computer experience, computer aptitude (as measured by the Computer

Aptitude Literacy and Interest Profile; Poplin, Drew & Gable, 1984) and math anxiety as predictor variables. Marcoulides found that computer anxiety was the strongest predictor of achievement, explaining 53 percent of the variance in achievement. Computer experience explained an additional 14 percent of the variance of achievement, while computer aptitude was the least significant predictor, explaining an additional 9 percent of the variance. Marcoulides found that math anxiety did not significantly contribute to the regression formula.

Griswold (1985) compared an ad hoc measure of computer attitude to the number of math courses taken in both high school and college, using 210 college students as subjects. He found no relationship between computer attitude and number of high school math classes taken, but did find a significant relationship between attitude and the number of college math classes taken ($r=.22$), indicating that those who had taken more math classes in college had more positive attitudes.

Munger and Loyd (1989) studied the possibility of predicting math performance. The predictor variables were calculator attitudes, measured using an ad hoc instrument and computer attitudes using the Computer Attitude Scale (Loyd & Gressard 1984b), which consisted of three subscales, computer anxiety, computer liking and computer confidence. The subjects were 69 high school students enrolled in a summer math enrichment program. They found that calculator attitudes and computer confidence correlated significantly with math performance ($r=.24$, and $r=.26$ respectively). Computer anxiety yielded a positive but nonsignificant correlation ($r=.11$).

These studies tend to support the assumption that many researchers have made, that math anxiety and computer anxiety are related constructs. They also tend to support the claim that computer anxiety and math anxiety are not identical constructs.

Reduction of Math and Test Anxiety

As mentioned earlier, math anxiety is related to computer anxiety. The work that has been reported in the area of reducing math anxiety offers guidance to the efforts of researchers who wish to design studies to reduce computer anxiety.

The relationship between computer anxiety and test anxiety is also interesting. Math, test, and computer anxiety are all intellectually based anxieties, quite different from other simple phobias such as the fear of snakes, or the fear of heights. Although "bad things can happen" as a result of being involved with computers, math, or tests, those "bad things" are not immediate or physical (like falling and hurting yourself, or being bitten by a poisonous snake), but are instead, much more constructs of the mind. This is an important reason to examine the research in these two areas. Also, these areas have been studied for a significantly longer time than computer anxiety.

Test anxiety is a construct that has been examined for almost 40 years (Mandler & Sarason, 1952; Sarason & Mandler, 1952; Sarason, Mandler & Craighill, 1952). The phenomenon has been examined in many ways by many researchers, yet there is still significant disagreement about some of the foundations of the construct. These disagreements have caused one recent author to state "test anxiety, despite its age is a construct in search of identity" (Hembree, 1988, p. 48).

In their pioneering research, Mandler and Sarason (1952) described task-directed drives that were opposed to learned anxiety drives. They called these drives test anxiety and described them as "feelings of inadequacy, helplessness, heightened somatic reaction, anticipations of punishments or loss of status and esteem, and implicit attempts to leave the testing situation" (p. 166). They found this anxiety to be related to a significantly lower and more inconsistent performance (Sarason, Mandler & Craighill, 1952). This caused them to theorize that lower anxiety allowed subjects to attend more easily to task-directed behaviors, and thus to improve performance.

Alpert and Haber (1960) further defined the construct of test anxiety as consisting of two components; an activating component, and a debilitating component. The activating component was seen as generally beneficial to the subject, and the debilitating component as harmful. This distinction has been accepted by the research community, and subsequently, test anxiety refers only to the debilitating component.

Liebert and Morris (1967) shifted their orientation toward study of test anxiety from a behavioral perspective to a cognitive perspective, by further dividing test anxiety into components of worry and emotionality. The worry component was "any cognitive expression of concern about one's own performance" (p. 975), while emotionality was behaviorally based (e.g., accelerated heart rate, or perspiration). Their study suggested that performance was depressed by worry, but unaffected by emotionality.

Wine (1971) combined some of the ideas of Liebert and Morris with the original ideas of Mandler and Sarason to propose an attentional theory to explain the performance effects of test anxiety. Preoccupation with worry, self-criticism, and somatic concerns caused subjects to be less attentive to task relevant issues involved with testing, and therefore performance was depressed.

Unfortunately, recent research reported on the reduction of test anxiety has not supported these interference models, and in fact has challenged the cause/effect relationship altogether. Treatment was found to be effective in reducing test anxiety, but improved performance did not accompany this reduced anxiety (Tyron, 1980). An alternative hypothesis was proposed by Tobias (1985), wherein awareness of poor past test performance causes test anxiety.

Hembree (1988) found 137 studies that reported on the treatment of test anxiety (TA). Only studies using control groups were examined. Behavioral treatments included systematic desensitization (or SD, the most common treatment), relaxation training, modeling, covert positive reinforcement, and hypnosis. SD programs were administered in a broad assortment of conditions: group or individual treatment, direct-contact therapy or a use of audio/video tapes, direct or vicarious participation by the subjects, and accelerated treatment versus a leisurely spread of treatment sessions. The TA scores of elementary and high school students treated by SD were significantly lower than the scores of untreated students. Similar results were reported for college students treated individually. However, college students treated in group settings seemed to profit the most from SD treatment.

The next most frequently reported behavioral treatment was relaxation training, which included cue-controlled relaxation (using a psychological trigger to induce relaxation) and training augmented with biofeedback. Hembre identified 32 studies using these techniques, and found the results to be highly consistent. All the studies reported a significant reduction in TA. There were 14 studies that used other behavioral techniques, and these too consistently reported significant reduction in TA. Hembree drew the conclusion that "all the behavioral treatments resulted in a TA reduction" (p. 67).

Hembree (1988) found that cognitive treatments, treatments using study skill training, or those using psychotherapy were not effective at reducing test anxiety. He also concluded that cognitive-behavioral treatments were no more effective than behavioral treatment alone.

The reason for examining test anxiety in this study was to incorporate what is known about treatment of test anxiety and to consider applying these procedures to the study of computer anxiety. From the information presented here, it would appear that behavioral treatments would be the most promising for reducing computer anxiety.

Math anxiety appears to be a somewhat newer construct than test anxiety. This simple phobia had its beginnings with a construct called "number anxiety", (Dreger & Aiken, 1957), and has developed into what is today called math anxiety.

Several studies have found that various treatments can be effective in reducing math anxiety (e.g., Bander, Russell & Zamostny, 1982; Donady & Auslander, 1979; Kostka & Wilson, 1986). The bulk of these studies used cognitive methods of treatment, mainly focusing on improvement of mathematics skills as a means of reducing anxiety. A few studies found behavioral treatments (systematic desensitization and relaxation techniques) to be effective in reducing math anxiety (Desper, 1988).

Tobias (1978) spent over ten years studying math anxious individuals. He suggested that math anxiety should be treated in a clinical setting, using group desensitization, and a group of cognitive techniques.

Bander, Russell and Zamostny (1982) compared relaxation to the study skills counseling approach as treatments for math anxiety. They found that improvement of study skills was effective in reducing math anxiety, while relaxation was not.

One strong difference between the study of the treatment of math anxiety and test anxiety was that there was a much stronger concentration in the area of math anxiety on the prevention of the development of the phenomenon than there was for test anxiety. The current approach for dealing with the problem of math anxiety was summarized by Cope (1988). "Anxieties, phobias, and other emotional responses to the environment can be difficult to eliminate. Thus, the most effective way to address math anxiety may be prevention rather than treatment" (p. 12). This sentiment may forecast the future efforts with respect to elimination of computer anxiety, but certainly do not describe today's situation because of the almost total lack of research based knowledge regarding the development of computer anxiety.

Computer Anxiety Reduction

Studies that have experimentally attempted to reduce computer anxiety are not numerous. As mentioned earlier, several studies have examined the effect of computer instruction, or computer exposure on computer anxiety. Several of these studies found that instruction and/or exposure to computers was effective at reducing computer anxiety. What was missing in these studies however was any manipulation of the situation for the purpose of identifying the features of the instruction or exposure that were most responsible for the anxiety reduction, or discovering what could enhance the instruction or exposure to produce even greater anxiety reduction (e.g relaxation techniques, cognitive restructuring, flooding, implosion, systematic desensitizition).

Three studies have been identified that have manipulated various variables in computer anxiety reduction programs. Lamb (1984) examined the effect of a video tape that was specifically designed to reduce computer anxiety. The tape used techniques found to be most effective in reducing anxiety, including "systematic desensitization, modeling, as well as cognitive and persuasive techniques" (p. 44). The design used was a posttest only-control group design (Campbell & Stanley, 1963), and the subjects were 138 college students enrolled in a junior level college educational media class. Experimental subjects' computer anxiety was assessed after viewing the video tape. While control subjects were assessed just prior to viewing the tape. "No significant difference was found between the means of the treatment and control group subjects on the Computer Anxiety Index" (p. 56).

Most of the literature on anxiety reduction either states or implies that reducing anxiety is a somewhat lengthy process (e.g., Kleinknecht, 1986; Ost, 1989; Thyer, 1987). The fact that this treatment took only a few minutes is probably the primary reason for its failure to produce positive results. There simply was not time for the subjects' computer anxiety to change.

Bloom and Hautaluoma (1990) nicely integrated much of the current thinking on anxiety reduction into a study of computer anxiety reduction. They examined the use of relaxation, and cognitive monitoring of negative self statements as well as user friendliness of computer software as it related to computer anxiety. Subjects were drawn from an introductory college psychology class. The entire class was tested using Oetting's COMPAS (a computer anxiety measure that has been available for some time, but which has not been widely used; Oetting, 1983). Those who met the following three conditions were identified as potential subjects: 1) scored in the top 25% of the class on the COMPAS, 2) no programming background, and 3) not enrolled in a computer course. Using this process, they gathered a subject sample of 80 (N= 80).

Bloom and Hautaluoma (1990) trained these subjects in relaxation, and what they called "cognitive coping". They used a 4 X 2 design, with four training groups (relaxation only, cognitive coping only, both relaxation and cognitive coping, and a control group which was trained in neither), and two levels of user friendly software. The software that was employed was a spreadsheet program. "Two software versions that performed identical spreadsheet operations were employed. However, the friendly version included the following resources that were absent from the less-friendly one: a screen menu summarizing the commands, extended explanations of errors, verification requests preceding data deletion, auditory clicks when keys were pressed, 'please wait . . .' messages when wait time exceeded about one second, and a HELP command that elicited 'on-line' instruction information." In a single session (lasting no more than two hours), subjects experienced their training, and had opportunities to practice the techniques they learned while using the computer.

The results showed that "contrary to prediction, planned one-tailed t tests showed computer anxiety to be unaffected by training method", although an overall reduction of computer anxiety was found. User friendliness of software was also found to be unrelated to a reduction in computer anxiety. As with the Lamb (1984) study, the main reason for a lack of positive results could likely be attributed to the short time frame that was used. Anxiety reduction is probably related to the time taken to complete the process. A second problem with this study was that an extremely anxious group of subjects were used. Subjects were chosen on the basis of their computer anxiety with the most anxious half of the subjects being given the treatment. The finding of a reduction of computer anxiety after the two hour session could be partially be explained by statistical regression towards the mean (Borg & Gall, 1989).

Rosen et al. (1989) employed an accepted clinical treatment program for anxiety reduction, and applied it to computer anxiety. Their work dealt with 149 highly computer anxious college students who volunteered for treatment. Their procedures included systematic desensitization and relaxation procedures similar to those described by Kleinknecht (1986). Their treatments involved 5 hours of clinical treatment over a 5 week period. Rosen, et al. concluded that "clients showed dramatic changes following the 5-week program. Nearly all clients showed markedly decreased anxiety, improved cognitions, and enhanced attitudes. Clients increased computer utilization on campus, in their personal lives, and on the job."

Synthesis of Anxiety Literature

From this review of literature, it seems clear that computer anxiety can be measured, and that its measurement is somewhat robust. The robustness of the construct is evidenced by the high level of correlation between measures found in the two studies that compared these measures (Dukes, Discenza & Couger, 1989; Kernan & Howard, 1990).

The literature as a whole also makes it clear that there is a relationship between computer experience, and computer anxiety. Which causes the other, or weather they each partially contribute to the other has not been firmly established.

Instruction has been shown to be effective for reducing computer anxiety, although not in every case. Longer treatments have in general been more successful at producing reduction of computer anxiety, and this is consistent with the literature on the treatment of simple phobias. However, the features of instruction that are responsible for the reduction have not been clearly defined, nor have any manipulated instructional treatment programs been shown to be more effective than the original instruction. The manipulations that have been tried thus far are consistent with the current philosophy of those working in the field of clinical treatment of simple phobias.

One group is successfully treating computer anxiety in a clinical setting, and doing so in a very short period of time (45 minutes). The work of this group is new enough that it has not been replicated or generalized to other settings.

Summary

Computer anxiety is a simple phobia. It can be measured. The construct is robust. There are several measurement instruments that have been developed, only a few of which have significant reliability and validity information as well as a significant acceptance by researchers studying the phenomenon. The Computer Anxiety Index (CAIN) has the strongest information base of any computer anxiety measurement instrument, and therefore was the best choice for this study of computer anxiety reduction.

Instruction can be effective in reducing computer anxiety, and the most promising treatments seem to be behaviorally based. These treatments include systematic desensitization, and relaxation training. A computer anxiety treatment program delivered in an instructional setting should involve these behavioral aspects to use the best information available to reduce computer anxiety.

Table 1: Correlations between four measures of computer anxiety (Dukes, Discenza & Couger (1989).

	BELCAT	CAS	CAIN
ATC	.77	.80	.80
CAIN	.87	.89	
CAS	.82		

ATC - Attitude Toward Computers (Raub 1981)
BELCAT - Blomberg-Erickson-Lowery Computer Attitude Task (Erickson, 1987)
CAIN - Computer Anxiety Index (Maurer, 1983)
CAS - Computer Attitude Scale (Loyd & Gressard, 1984)

METHODOLOGY

This chapter contains five sections. First, the students who were the study's subjects are described. Second, the measurement instruments that were used are explained. Third, the experimental procedures are discussed. Fourth, the methods used to analyze the data are explained. The last section summarizes the methodology used in this study.

Subjects

The subjects that were used for this research were college students enrolled in an introductory course on computers in education. The course was designed for the novice user with little or no experience using computers. The course was not required for graduation, or certification, so enrollment was voluntary. It was a semester long, three credit course, with two hours of lecture and two hours of lab per week. The enrollment was 120 students in nine sections.

Students enrolled in the course were primarily education majors (84%). The age range of the students was was primarily from the late teens to mid twenties. There was a small percentage of older students (approximately 5%). The gender ratio was 19% males and 81% females.

Students were told that an experiment was being conducted, but they were not told that it involved the treatment of computer anxiety. It was thought that this revelation could significantly bias the results. Participation in the study was voluntary. Since all experimental treatments occurred during regular class time participation was very high (98%).

Tests

Subjects were given two instruments, the Computer Anxiety Index (CAIN; Maurer 1983) and the Need for Cognition Scale (NCS; Cacioppo & Petty, 1982). The CAIN is a 26 item paper and pencil measure using a six point Likert scale. The intent of the instrument is to assess the level of computer anxiety of the individual taking the test. The possible range of scores is from 26 to 156. Normative information previously collected for college students produced a mean of 70.2 (Maurer, 1983). The distribution of scores of the norm groups was found to be skewed, with a greater number of respondents falling on the low anxiety end of the scale. It was also found that "each group tested had a small percentage of scores on the highly anxious end of the scoring range that were separated from the rest of the scores (p. 57).

In conjunction with administration of the CAIN, students were asked three additional questions. They were asked to report their grade level, whether they had previously taken a computer literacy course, and how many semesters of course-work they had taken related to computers.

The NCS is an 18 item measure that uses a five point Likert scale. The range of scores are from 18 to 90. It was designed to measure "the tendency for an individual to engage in and enjoy thinking" (Cacioppo & Petty, 1982, p. 116). Significant reliability and validity information has been gathered for this measure (Cacioppo & Petty, 1982; Cacioppo, Petty & Kao, 1984; Cacioppo, Petty, Kao & Rodriguez, 1986;). Furgeson, Chung and Wiegold (1985) reported a Chronbach's alpha of .86 (r = .86).

This measure is thought to relate strongly to motivation to achieve in a cognitive setting. It was originally designed to be used in marketing research, to identify groups for whom different kinds of advertising was effective. Early research using this measure focused on change of attitude toward specific products, and the persistence of those attitude changes. Normative data is not available for this instrument. Research using it has used a "median split method", dividing groups taking the measure in two halves, with those scoring higher being identified as the "high need for cognition" group, and those scoring lower being identified as the "low need for cognition" group.

Course grades in both the lab section of the class as well as the lecture section of the class were used as measures of achievement. Grades for this course are made up of six components; 1) scheduled lecture tests, 2) unannounced lecture quizzes, 3) a standard set of lab assignments, 4) a hands-on lab midterm, 5) a final lab project, and 6) various lab grades that vary from lab section to lab section (e.g., lab quizzes, lab attendance, extra credit assignments). Lecture tests and quizzes were multiple choice and machine scored. The tests consisted of a midterm and a final, with 80 questions each. There were 8 quizzes, with an average of five questions on each quiz. Students were not allowed to "make up" a missed quiz unless they made arrangements to do so prior to the administration of the quiz.

The standard set of lab assignments were a group of 12 assignments, covering each of eight lab topics. They include: 1) an assignment using the graphics program PrintShop on Apple IIe computers, 2) three word processing assignments using AppleWorks on Apple IIe hardware 3) two Logo assignments using LogoWriter on Apple IIe computers 4) a data base management assignment using Bank Street Filer on Apple IIe computers 5) an assignment using the Macintosh computers with MicroSoft Works word processing and McPaint graphics software, 6) two assignments using IBM computers and Lotus 1-2-3, 7) a HyperCard assignment using Macintosh hardware, and 8) a desk top publishing assignment using Apple IIe hardware. Each of these assignments was graded independently by each lab instructor, based on a criterion form included in the student textbook (Thompson, 1990). Points were assigned to various aspects of each assignment, and each lab instructor was directed to follow the grading criterion in assigning points to each assignment. The point value of assignments varied according to the complexity of the assignment, with the lowest number of points being five, and the greatest number being 16. The total number of possible points for the nine assignments was 150.

The lab midterm was a hands-on examination using Apple IIe computers. Students were tested in two areas, AppleWorks word processing and Logo using Apple IIe computers. Students were given a standard problem set, and a common grading criterion. The word processing exercise consisted of a document containing explicit instructions for modifying that document. The product was graded according to how well students were able to execute the directed changes to the document. The maximum number of points on the word processing portion of the midterm was 20.

The Logo portion of the midterm consisted of five problems. Each problem was a different geometric design that students were asked to reproduce by writing a Logo procedure. The students were again given an explicit grading criterion. They were graded according to correctness of the desired output, as well as use of higher level programming constructs (e.g., using variables and recursion). Specific points were assigned to each procedure according to the following scale: 0 points - not attempted, 1 point - attempted but incorrect, 3 points - program output is partially correct, 5 points - program runs perfectly. Two points were also added to each problem for programming efficiency and style. Extra points were assigned to two exercises according to the following criteria: add 1 point if variables were used, and 2 points if they are used extensively; add 1 point if recursion is used, and 2 points if it is used extensively. The maximum score on the Logo portion of the midterm was 31 points. Grading of the midterm was done by the individual lab instructor.

The final projects for the lab section of the course was an in-depth application of computer software to education. Students were directed to select software that was of interest to them, that applied to their area of specialization, and that went beyond what had been covered in class. The grading criteria was included in their text book, and this served to further direct their selection of a project. The grading was done based on appropriateness of their topic (10 points), expansion of class topic (10 points), completeness (10 points), efficiency and style (10 points) and documentation (10 points). The maximum number of points for the final project was 50.

The lecture grades and lab grades were analyzed separately because it was thought that lecture grades were more an indication of declarative knowledge, while lab grades were more an indication of procedural knowledge. The distinction between procedural knowledge and declarative knowledge is made as follows by Howes. "Declarative codes involve the specification of data as such in propositional, symbolic form. 'A dog is an animal' or 'Wine is grown in Normandy,' as expressed here, correspond to declarative information. Procedural information, on the other hand, involves knowledge of how to do something, such as knowledge of how to tie one's shoelaces or drive a car (Howes, 1990, p. 133)."

The lecture quizzes were eliminated from the lecture grades to eliminate the effect of student absences. The lecture grade used in this study was the sum of the points earned on the lecture midterm, added to the number of points earned on the final test. The maximum number of points possible was 160.

In compiling the lab grade, portions of the grades that were not consistent from lab section to lab section were eliminated. The lab grade consisted of the sum of the points associated with the standard set of assignments, the lab midterm, and the final project. The maximum number of points for the lab section of the course was 251.

Experimental Procedures

Administration of Instruments

Introduction of students to the experiment During the first meeting of the course, students were given a letter asking them to participate in an experiment that would be taking place during the semester (see appendix A). This letter explained that the experiment involved a study to improve teaching with and about computers. The letter made it clear that participation was voluntary, and that there was no risk anticipated to the student, either physically or academically as a result of participating. The letter encouraged students to participate. Along with the distribution of this letter, they were verbally told the same information by their instructor.

CAIN The Computer Anxiety Index (CAIN) was given to students at three times throughout the semester. The first administration was during the first week of the course. The second was approximately seven weeks into the course. The third administration was during the final two weeks of the course. The CAIN was administered in the lecture section of the class, and an attempt was made to get 100% participation by having any students who missed the testing period complete the CAIN either in a lab, or in a subsequent lecture. No "make-up" CAIN tests were given more than a week after the initial information was collected, with the exception of the final administration, for which make-ups were collected over a 12 day period.

On the CAIN questionaires students were asked to answer three questions prior to responding to the 26 standard anxiety items. They were asked to indicate their grade level (1 for freshman, 2 for sophomore, 3 for junior, 4 for senior, and 5 for graduate student), they were asked to indicate if they had previously taken a computer literacy course, and they were asked how many semesters of computer literacy they had previously taken.

NCS The Need for Cognition Scale (NCS; Cacioppo & Petty, 1982) was administered once during the second week of the course. As with the CAIN, it was administered in the lecture section of the course, and any students who missed taking the NCS in the lecture were asked to complete it in their lab.

Achievement The achievement information for the lab section of the course was gathered from each lab section instructor during the last week of the semester. Lecture grades were obtained as soon as they were available after the completion of the semester. This information was collected to determine if there was a relationship between computer anxiety and achievement in a computer related course, and if there was a relationship between *change* in computer anxiety and achievement in a computer related course. Of particular interest was the effect of the treatments of the study on resulting achievement. It was hypothesized that relaxation training would slightly improve performance in the lab section of the course, because of reduced anxiety while students were interacting with the computers after their relaxation session.

Relaxation Training

Each lab was randomly divided into two groups using a table of random numbers (Hopkins & Glass, 1978, p. 406). Even numbers were assigned to the relaxation group (N=55), while odd numbers were assigned to the control group (N=59). Since there were a number of students who added this course during the early days of the semester, random numbers were also assigned to each lab section, so lab instructors would know to which treatment group any new students should be assigned. To keep the treatment and control groups seperated, two rooms were used. One room was the regular classroom, and the other was different room. The location of the treatment was randomly assigned and resulted in four of the nine control groups meting in the regular classroom.

The relaxation and control exercises began the second week of the semester, and continued through the second to the last week of the semester, each time the lab met (a total of 11 meetings). The relaxation group was trained in a basic muscle relaxation procedure. The processes were derived from those of Beech, Burns and Sheffield (1982). Because the entire exercise was rather lengthy, it was divided into five separate sessions. Each session focused on a different group of muscles. The sessions were delivered one per week, in the order described by Burns and Sheffield and were repeated in the same order throughout the semester.

These relaxation exercises were recorded on audio tape and were played for the experimental subjects exactly as printed in Beech, Burns and Sheffield. They were played at the beginning of each lab period by either the experimenter, the lab instructor, or another teaching assistant. Roll was taken before each class meeting, and any students who arrived after the relaxation instruction had begun were marked as late, and any students missing were so indicated on the roll sheet. The group leader was instructed to sit and model the relaxation exercise with the students. Each exercise began by asking students to close their eyes at the beginning of the relaxation exercise. Group leaders made surreptitious observations of subjects to ensure that subjects were following the relaxation instruction (See appendix B for transcripts of the tapes).

During the next to the last meeting of the treatment groups, the subjects were given a short questionnaire relating to the relaxation exercises (see appendix D). Subjects were asked if they were participating in the relaxation exercises in class, if they felt more relaxed after the exercise, and if they thought relaxation was applicable to the teaching learning environment. In addition, they were asked to write any comments that they had while participating in the exercise. This was a self reported check of participation and effectiveness of the relaxation training. Although, it was possible to observe if people were following the relaxation directions, it was difficult to determine if those processes were having the desired effect.

Control Group Training

The control group was told that they were involved in a study exploring the effects of improved knowledge of computer terms on learning about computers. Each week they were given a new "word of the week." The word was defined, and students were asked to use the word at least once in their normal conversation, and as often as they could during the following week. They listened to an audio tape about the word similar in length, and under the same circumstances as the relaxation group.

A typical "word of the week" tape introduced a common computer word (e.g., byte), defined it, and gave some background information about the word. Information elaborating on the meaning and use of the word was given (e.g., how many bits make up a byte, and how many bytes can be stored on a floppy disk). Students were given three or four examples of sentences that used the word, and they were reminded to use it whenever it would be appropriate to do so throughout the week (see appendix B for a transcript of the control tapes).

To maintain consistency of procedure between the control group and the experimental group, the control group was given a questionnaire similar to the one given to the experimental group. They were asked if they paid attention to the word of the week tape, if they learned anything from it, and if they thought the process would be useful in a teaching/learning environment. In addition, and consistent with the experimental group, they were asked to comment on the process.

Data Analysis

The 12 hypotheses put forward in chapter 1 were each examined individually. The alpha level for each test was set at the .05 level (Hinkle, Wiersma & Jurs, 1988). The following is a description of how each hypothesis was be examined, and the statistical tests that were used:

Hypothesis 1: (Students with previous computer literacy training have significantly lower precourse computer anxiety than those with no previous computer literacy training.) The mean of the precourse CAIN score was compared between students who indicated having previous computer literacy training and those who indicated having no previous training. This comparison was done using an independent t test.

Hypothesis 2: (The computer anxiety of students involved in a semester long computer literacy course will be significantly lower after the course than it was at the beginning of the course.) The mean of the precourse CAIN score was compared to the mean postcourse CAIN score. This comparison was done using a paired t test. A significant difference between these means would suggest that participation in the course was responsible for a change in computer anxiety.

Hypothesis 3: (The computer anxiety of students after the first six weeks of a computer literacy course is not significantly different from their computer anxiety at the beginning of the course.) The mean of the precourse CAIN score was compared to the mean of the midcourse CAIN score. This comparison was done using a paired t test. No significant difference would suggest that little change occured during the first half of the course.

Hypothesis 4: (The change in computer anxiety of participants in a semester long computer literacy course is different for students with previous computer literacy training than for those without previous computer literacy training.) Postcourse CAIN scores were compared for those who indicated that they had previously taken a computer literacy course to those who indicated they had not previously taken such a course. This analysis was done using analysis of variance, with previous training as the independent variable, and CAIN scores as the dependent variable. Differences in precourse computer anxiety was taken into account by using a repeated measures design (Hinkle, Wiersma & Jurs, 1988), using precourse and postcourse CAIN scores as the repeated measures. A significant interaction between the repeated measures, and previous experience would indicate that there was a significant difference in the postcourse CAIN means for these two groups considering differences in precourse means.

Hypothesis 5: (Students who participate in a semester long relaxation training program in conjunction with a computer literacy course will have significantly lower postcourse computer anxiety than students who participate in the computer literacy course without the relaxation exercises.) Postcourse CAIN scores were compared for the experimental (relaxation) and control (no relaxation) groups. This analysis was done using analysis of variance, with treatment group as the independent variable, and CAIN scores as the dependent variable. Differences in precourse computer anxiety was taken into account by using a repeated measures design (Hinkle, Wiersma & Jurs, 1988), using precourse and postcourse CAIN scores as the repeated measures. A significant interaction between the repeated measures, and the treatment group would indicate that there was a significant difference in the postcourse CAIN means for these two groups considering differences in precourse means.

Hypothesis 6: (There is a significant negative relationship between precourse computer anxiety and the personality variable, need for cognition, for participants in a semester long computer literacy course.) The relationship of the between the precourse CAIN score for all subjects was compared to the their "need for cognition" score. This was done using a Pearson product moment correlation (Hinkle, Wiersma & Jurs, 1988).

Hypothesis 7: (There is a significant relationship between "need for cognition" and reduction of computer anxiety for participants in a semester long computer literacy course.) The postcourse CAIN scores were correlated with need for cognition scores, using a partial correlation to remove possible effects of differing precourse computer anxiety. This was done using a partial correlation as suggested by Borg and Gall. They describe a situation in which the effect of differing instructional technique was used as the independent variable, and final achievement was used as the dependent variable. The partial correlational technique is used "so that we can determine the influence of instructional factors on end-of-year achievement independently of the influence of (a) beginning-of-the-year achievement on end-of-the-year achievement and (b) beginning-of-the-year achievement on instructional factors (Borg & Gall, 1989, p. 600)." A significant correlation would indicate a relationship between "need for cognition" and reduction of computer anxiety.

Hypothesis 8: (There is a significant negative relationship between precourse computer anxiety and final grade in a computer literacy course.) The final grades in the course (lecture and lab combined) were compared to the precourse CAIN score. This was done using a Pearson's product moment correlation. A significant negative correlation would suggest that high levels of computer anxiety, prior to taking a computer literacy class are related to lower performance in the class.

Hypothesis 9: (There is a significant negative relationship between postcourse computer anxiety and final grade in a computer literacy course.) The final grade in the course (lecture and lab combined), was compared to the postcourse CAIN score. This was done using a Pearson's product moment correlation. A significant negative correlation would suggest that high levels of computer anxiety at the end of a computer literacy class are related to lower performance in the class.

Hypothesis 10: (The relationship between postcourse computer anxiety and grade in a computer literacy course will be significantly stronger than the relationship between precourse computer anxiety and final grade.) This hypothesis was tested by comparing the two correlations, precourse CAIN score with course grade, and postcourse CAIN score with course grade. This was done by computing a t value for the two dependent correlations as suggested by Hinkle, Wiersma and Jurs (1988, p. 279).

Hypothesis 11: (The relationship between change in computer anxiety and course achievement is greater in the lab portion [hands-on assessment of achievement] than in the lecture portion [paper and pencil assessment of achievement] of a semester long computer literacy course.) The partial correlation between postcourse CAIN scores and lab grade, controlled for precourse CAIN scores was compared to the same partial correlation between postcourse CAIN scores and lecture grade. This was done by computing a t value for the two dependent correlations as suggested by Hinkle, Wiersma and Jurs (1988, p. 279). A higher correlation for the lab section, and a significant difference between the correlations would suggest that computer anxiety has a greater effect on the more hands on oriented activities that were done in the lab section of the course.

Hypothesis 12: (Participants in relaxation training have significantly higher grades in the lab portion of a computer literacy course than the control group, but do not have significantly higher grades in the lecture portion of the course.) The means grades for the relaxation group was compared to the mean grades for the control group. The lecture grades and lab grades were compared separately. This was done using two t tests. A significant difference for the lab section and no significant difference for the lecture section of the course would suggest that the relaxation exercises were more effective in improving the hands-on related work done in the lab than they were with the paper and pencil related work done in lecture.

Summary

The primary focus of this study was to determine if relaxation is effective in reducing computer anxiety in a computer literacy course. Relaxation exercises could potentially be a useful instructional technique for instructors of computer literacy. Relaxation exercises could reasonably be built into instruction relating to computers.

A second aspect of this study was of a confirmatory nature. Previous research found that computer anxiety reduction took place primarily in the second half of a semester long computer course. This study attempted to replicate that finding.

Other aspects of the study were of a more exploratory nature, particularly the relationship of need for cognition to computer anxiety and relaxation training as well as the relationship of achievement, computer anxiety and relaxation training. Further information in these exploratory areas may give guidance in the design of subsequent studies relating to the reduction of computer anxiety.

The information that will be necessary to complete this study includes three CAIN scores (precourse, midcourse and postcourse), an NCS score, an indication of previous computer literacy training, lecture grade, lab grade, total grade and an indication of assignment to the control group or the experimental group. To simplify the discussion of these variables, they have each been assigned an acronym (see Table 2). The three CAIN scores (pre, mid and postcourse) will be called CAIN1, CAIN2 and CAIN3, respectively. The need for cognition score will be referred to as the NCSS. When using the treatment group as a variable, it will be referred to ad TRMNT. The indication of having previous computer literacy training, or not, will be referred to as PTRN. Lecture grade and lab grade will be referred to as LEC and LAB, and the total of these two will be called GRADE.

Table 2: Acronyms for variables used in the study

Precourse Computer Anxiety Index score	CAIN1
Midcourse Computer Anxiety Index score	CAIN2
Postcourse Computer Anxiety Index score	CAIN3
Need for Cognition Scale score	NCSS
Treatment group (relaxation or control)	TRMNT
Previous computer literacy training (yes or no)	PTRN
Lecture score	LEC
Lab score	LAB
Total score (Lab score plus lecture score)	GRADE

RESULTS

This chapter contains seven sections. The first section describes the identification of the final subject population. The second section describes results relating to participation in the computer literacy course, and previous experience in a computer literacy course. The third section provides results relating to the relaxation treatment, and the fourth section describes results relating to need for cognition. The fifth section explains results relating to achievement in a semester long computer literacy course, and the sixth section describes the relationship between the relaxation treatment and achievement in the course. The last section is a summary of the results of this study.

Subjects

The subjects for this study were the group of students enrolled in an introductory, undergraduate computer literacy course for teachers. The course was not required either for graduation, or for certification to teach. The registration for this course was 121 students. These students were randomly assigned to either the relaxation group, or the control group. Two additional students added the course too late to be included in the study. Of the original 121 students, 59 were assigned to the experimental group, and 62 were assigned to the control group. Nine students from the experimental group (leaving 50) and four from the control group (leaving 58) dropped the course.

Final grades were given to 110 students. As mentioned above, two of these students were not included in the study because they entered the course after the study had begun. Every attempt was made to collect complete information on all students in the class, but because the computer anxiety scores that were collected were associated with a specific time within the course (at the beginning, after 6 weeks, and at the end), it was not possible to collect CAIN scores on a small number of subjects (e.g., those who were absent for the entire 6th week of the semester). Of the 110 students who completed the course, 7 were eliminated from the subject population because of incomplete information, three from the experimental group, and four from the control group. The final subject population was 101 subjects (N = 101), 47 in the experimental group, and 54 in the control group.

Participation in this study was presented to students as completely optional. Although students were strongly encouraged to participate in this study at its beginning, their grade in the course was not affected. However, since the experimental treatments were performed in the lab, participation in the experiment was very high. Only two students who completed the course chose not to take part in this study (one from the control group, and one from the experimental group). In addition, one student was dropped from the study because she was frequently absent for the relaxation exercises.

Computer Anxiety Results

The Computer Anxiety Index (CAIN; Maurer, 1983) was administered three times during this study, once at the beginning of the semester long computer literacy course, once midway through the course, and last at its end. The means, standard deviations and Coefficient Alpha (Allen & Yen, 1979), for the three administrations of the CAIN for all subjects are provided in Table 3. Reliability was high for all administrations of the CAIN. This is consistent with previous research that has been reported that used this test.

Along with the first administration of the CAIN, subjects were asked to indicate if they had previously taken a computer literacy course (yes or no). The answer to this question was used to separate the students into two groups. The results of the three administrations of the CAIN for students who had and had not previously taken a computer literacy course are shown in Table 4.

Subjects were randomly assigned to either a relaxation group (experimental), or a control group. Of those students who remained in the subject population for this study, 47 (N = 47) were in the relaxation group, and 54 (N = 54) were in the control group. The results of the three administrations of the CAIN for these two groups are shown in Table 5.

Hypothesis 1 (Students with previous computer literacy training have significantly lower precourse computer anxiety than those with no previous computer literacy training.) was tested using a paired t test (Hinkle, Wiersma & Jurs, 1988). The results of this test were significant at the .05 level, so the hypothesis was supported (see Table 6). Students with previous computer literacy training entered this computer literacy course with lower computer anxiety.

Hypothesis 2 (The computer anxiety of students involved in a semester long computer literacy course will be significantly lower after the course than it was at the beginning of the course) was tested by comparing the average CAIN1 with the average CAIN3 using a paired t test (Hinkle, Wiersma & Jurs, 1988). The results of this test were significant at the .05 level, so the hypothesis was supported (see Table 7). There was a significant decrease in computer anxiety after participation in the computer literacy course.

Hypothesis 3 (The computer anxiety of students after the first six weeks of a computer literacy course is not significantly different from their computer anxiety at the beginning of the course) was an attempt to replicate a finding reported by Honeyman and White (1987). This hypothesis was tested by comparing the average CAIN1 with the average CAIN2 score using a paired t test (Hinkle, Wiersma & Jurs, 1988). The results of this test were not significant (see Table 8). Computer anxiety was not significantly reduced during the first six weeks of the computer literacy course. Although these two means were not found to be significantly different, it may be important to future research to note the direction of the change. The average CAIN2 was higher than the average CAIN1.

Hypothesis 4 (The change in computer anxiety of participants in a semester long computer literacy course is different for students with previous computer literacy training than for those without previous computer literacy training.) was tested using analysis of variance for repeated measures (Hinkle, Wiersma & Jurs, 1988). This technique examines the difference between groups across time. The pertinent statistic in this test is the interaction between groups (previous computer literacy training) and testing occasion (CAIN1 and CAIN3). The variable PTRN was used to divide the subjects into two groups and CAIN1 and CAIN3 were the repeated measures. The interaction was found to be significant at the .05 level (see Table 9). This supports the claim that the change that occurred between the beginning and the end of the course was different between the two groups. Students with no previous computer literacy training experienced significantly greater reduction in computer anxiety than those with previous computer literacy training.

Effects of Relaxation on Computer Anxiety

The relaxation treatments described in the previous chapter were successfully performed prior to each of 11 lab sessions. During the relaxation sessions, a moderator modeled the relaxation procedure. The first step in each relaxation session was for the subjects to close their eyes. This made it possible for the moderator to surreptitiously observe the subjects intermittently during the relaxation sessions. Most of the relaxation exercises involved very noticeable behaviors that could be observed. The moderators noted that with only very rare exceptions, all subjects actively participated in the relaxation exercises.

Attendance lists for each relaxation session were kept. While some subjects were absent for some relaxation sessions, of the subjects included in the sample, all attended at least nine of the 11 relaxation treatments. As noted earlier, one subject was dropped from the study because she was consistently absent for the relaxation treatments.

Although subjects followed the directions for the relaxation exercises, it was not possible to determine if the subject actually felt more relaxed after the exercises. In an attempt to determine if the relaxation exercises were effective, a self report measure was given to subjects prior to their final relaxation treatment. They were asked to indicate if they had actively participated in the relaxation exercises (yes or no). They were also asked to indicate on a four point scale how much more relaxed they felt after the exercises than before (1 = none, 2 = slightly, 3 = moderately, and 4 = highly, see appendix D for the full self report survey). The results of this survey are shown in Table 10. The majority of subjects (91%) indicated that they had actively participated in the relaxation exercises. Of the 47 relaxation subjects, 11 (23%) said that they had were no more relaxed after the exercise, 28 (60%) said they were slightly more relaxed, 8 (17%) said they were moderately more relaxed, and none said that they were highly relaxed after the exercises. It was concluded that the relaxation treatments were slightly effective. Several comments in the open ended section of the survey indicated that it was difficult to relax knowing that the stress of the course awaited ("It was hard to relax when I knew I had to go to lab afterwards." "The lab is so stressful for me that I couldn't relax much.").

Hypothesis 5 (Students who participate in a semester long relaxation training program in conjunction with a computer literacy course will have significantly lower postcourse computer anxiety than students who participate in the computer literacy course without the relaxation exercises.) was tested using a repeated measures analysis of variance (Hinkle, Wiersma & Jurs, 1988). The treatment group (relaxation, or control) was used as the independent variable, and CAIN1 and CAIN3 were the repeated measures. The CAIN1 and CAIN3 for both treatment groups are shown in Table 11. The interaction between treatment group and time was not significant at the .05 level.

Relationship between Need for Cognition and Computer Anxiety

The Need for Cognition Scale was taken by all subjects at the beginning of the course. This measure yields a score that is indicative of an individual's innate desire to engage in cognitive activities. Previous research found a relationship between this measure, and attitude change in an advertising and marketing context. It was thought that this measure would relate to CAIN1, since computers can be thought of as cognitively related devices. It was also thought that need for cognition would relate to change in computer anxiety because of previously reported research (Cacioppo, Petty, Kao & Rodriguez, 1986).

Hypothesis 6 (There is a significant negative relationship between precourse computer anxiety and the personality variable, need for cognition, for participants in a semester long computer literacy course.) was tested using a Pearson's product moment correlation (Hinkle, Wiersma & Jurs, 1988). This correlation was .17 ($r = .17$). This correlation was not negative, and it was not significant at the .05 level (see Table 15).

Hypothesis 7 (There is a significant relationship between "need for cognition" and reduction of computer anxiety for participants in a semester long computer literacy course.) was tested using a partial correlation, removing the influence of precourse computer anxiety (Borg & Gall, 1989). The partial correlation was .26 ($r = .26$). This correlation was significant at the .05 level. The need for cognition score was positively related to CAIN3 when the influence of CAIN1 was removed, thus indicating that there was a significant relationship between change in computer anxiety and need for cognition.

To clarify this relationship, a median split was done using the need for cognition score. This produced a high need for cognition group, and a low need for cognition group.

The mean precourse and postcourse CAIN scores were calculated for each group and the difference was calculated from these means (CAIN1 minus CAIN3) to yield a reduction in computer anxiety score (RCAS). Table 13 shows RCAS by need for cognition, indicating that individuals with lower need for cognition had a greater change in computer anxiety. This is consistent with findings in the advertising field that used the Need for Cognition Scale (Cacioppo, Petty, Kao & Rodriguez, 1986).

The Relationship between Achievement and Computer Anxiety

In an attempt to further establish the relationship between computer related achievement and computer anxiety, course grades were examined with respect to both precourse computer anxiety, and change in computer anxiety. Since the course was a lecture/lab class the grades from the lecture and the lab were examined separately.

Hypothesis 8 (There is a significant negative relationship between precourse computer anxiety and final grade in a computer literacy course.) was tested using the sum of LAB and LEC, to produce GRADE. GRADE was compared to CAIN1 using a Pearson's product moment correlation. The correlation between precourse CAIN and final grade was -.16 ($r = -.16$). Although the direction of the correlation was negative as hypothesized, it was not significant at the .05 level (see Table 15).

Hypothesis 9 (There is a significant negative relationship between postcourse computer anxiety and final grade in a computer literacy course.) was tested using a Pearson's product moment correlation. GRADE was correlated to CAIN3. This correlation was -.33 ($r = -.33$). This correlation was significant at the .05 level (see Table 15), indicating that students with higher course grades tended to have lower levels of computer anxiety at the end of the course.

Hypothesis 10 (The relationship between postcourse computer anxiety and grade in a computer literacy course will be significantly stronger than the relationship between precourse computer anxiety and final grade.) was tested by comparing the two correlations using a t test as described by Hinkle, Wiersma and Jurs (1988, p. 279), using the following correlations: CAIN1 with GRADE, CAIN3 with GRADE and CAIN1 with CAIN3. The t value was 2.60 ($t = 2.60$). This t was significant at the .05 level.

Hypothesis 11 (The relationship between change in computer anxiety and course achievement is greater in the lab portion [hands-on assessment of achievement] than in the lecture portion [paper and pencil assessment of achievement] of a semester long computer literacy course.) was tested by computing a t value for the two partial correlations (Hinkle, Wiersma & Jurs, 1988, p. 279).

The partial correlations were calculated by correlating CAIN3 and the respective grades (LEC and LAB), controlling for CAIN1. The partial correlation between the CAIN3 and LAB was -.28 ($r = -.28$), and was found to be significant at the .05 level. The partial correlation between CAIN3 and LEC was -.31 ($r = -.31$). The hypothesis stated that the relationship between lab grade and postcourse computer anxiety was stronger than lecture grade ans postcourse computer anxiety. Since this was not found to be the case, the significance of the difference between the two partial correlations was not tested.

Relaxation and Achievement

The relaxation exercises were done just prior to weekly labs. It was hypothesized that this relaxation would not only reduce computer anxiety, but also have a positive effect on achievement in the lab portion of the course. It was further hypothesized that the relaxation treatment would have no effect on achievement in the lecture portion of the course.

Hypothesis 12 (Participants in relaxation training have significantly higher grades in the lab portion of a computer literacy course than the control group, but do not have significantly higher grades in the lecture portion of the course.) was tested using two t tests. The average lab grade for the relaxation group was compared to the average lab grade of the control group. The average lecture grades were compared similarly (see Table 11). Neither pair of scores were significantly different.

Summary

Twelve hypotheses were proposed for this study. Hypotheses 1 through 4 were replications of other research, and both of these hypotheses were supported. Hypotheses 5 and 12 both dealt with effects of the relaxation treatment. Neither of these hypotheses were supported. Hypothesis 6 and 7 both dealt with the relationship between the personality variable "need for cognition." Hypothesis 7 was supported while hypothesis 6 was not. Hypotheses 7 through 12 all dealt with achievement. Hypotheses 7, 9 and 10 were supported, while hypotheses 8, 11 and 12 were not.

Table 3: CAIN scores for all subjects

	Mean	Standard Deviation	Coefficient Alpha	N
All subjects				101
CAIN1	55.24	18.75	.94	
CAIN2	57.68	21.71	.95	
CAIN3	49.45	17.82	.94	

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN2 = Midcourse CAIN score
CAIN3 = Postcourse CAIN score

Table 4: CAIN scores and difference in CAIN scores for subjects with previous computer literacy training, and without previous computer literacy training

	Mean	Standard Deviation	N
Subjects with previous computer literacy training			69
CAIN1	50.58	16.33	
CAIN2	54.24	21.47	
CAIN3	47.21	17.40	
CAIN2 - CAIN1	3.66		
CAIN3 - CAIN2	-7.03		
CAIN3 - CAIN1	-3.37		
Subjects without previous computer literacy training			32
CAIN1	65.28	19.92	
CAIN2	65.09	20.64	
CAIN3	54.16	18.08	
CAIN2 - CAIN1	-0.19		
CAIN3 - CAIN2	-10.93		
CAIN3 - CAIN1	-11.12		

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN2 = Midcourse CAIN score
CAIN3 = Postcourse CAIN score

Table 5: CAIN scores for subjects by experimental treatment group

	Mean	Standard Deviation	N
Experimental subjects (relaxation group)			47
CAIN1	56.92	18.77	
CAIN2	59.08	22.61	
CAIN3	49.11	17.86	
Control subjects			54
CAIN1	53.78	18.78	
CAIN2	56.46	21.02	
CAIN3	49.74	17.96	

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN2 = Midcourse CAIN score
CAIN3 = Postcourse CAIN score

Table 6: Independent t test comparing the average precourse CAIN score of subjects with previous computer literacy training to those without previous computer literacy training

	Mean	N	Degrees of Freedom	t	Significance
Subjects with previous computer literacy training	50.58	69	99	3.92	.0004
Subjects without previous computer literacy training	65.28	32			

CAIN = Computer Anxiety Index (lower score = less anxiety)

Table 7: Paired t test comparing CAIN1 and CAIN3 for all subjects

	Mean	N	Degrees of Freedom	t	Significance
CAIN1	55.24	101	100	4.56	.0001
CAIN3	49.45	101			

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score

Table 8: Paired t test Comparing CAIN1 and CAIN2 for all subjects

	Mean	N	Degrees of Freedom	t	Significance
CAIN1	55.24	101	100	1.51	.13
CAIN2	57.68	101			

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN2 = Midcourse CAIN score

Table 9: Repeated measures analysis of variance comparing those with previous computer literacy training to those without (PTRN), over time (CAIN1 and CAIN3)

Descriptive Information	Subjects with Previous Computer Literacy Training	Subjects without Previous Computer Literacy Training
CAIN1		
Mean	50.58	65.28
Standard Deviation	16.33	19.92
Number of Subjects	69	32
CAIN3		
Mean	47.21	54.16
Standard Deviation	17.40	18.08
Number of Subjects	69	32

Analysis of Variance	Sums of Squares	DF	Mean Squares	F	Significance
PTRN	5098.37	1	5098.37	9.40	.003
Time (CAIN1 & CAIN3)	2280.41	1	2280.41	30.25	<.001
PTRN X Time	666.07	1	666.07	8.83	.004

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score
PTRN = Previous computer literacy training

Table 10: Summary of self report data on participation in relaxation treatments, and level of relaxation after the treatments for students in the experimental (relaxation) treatment.

I participated in the relaxation exercises

Response	Yes	No	Total
Number responding	43	4	47
Percent of response	91%	9%	

How much more relaxed did you feel after the exercise?

Response	None	Slight	Moderate	High
Number responding	11	28	8	0
Percent of response	23%	60%	17%	0%

Table 11: Precourse and postcourse CAIN means and standard deviations for treatment groups

	Relaxation		No relaxation	
	Mean	Standard Deviation	Mean	Standard Deviation
CAIN1	56.92	18.79	53.78	18.79
CAIN3	49.11	17.86	49.74	17.96

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score

Table 12: Repeated measures analysis of variance comparing treatment groups (relaxation or control; TRMNT), over time (CAIN1 and CAIN3; see table 11 for descriptive statistics)

	Sums of Squares	DF	Mean Squares	F	Significance
TRMNT	78.70	1	78.70	.13	.716
Time (CAIN1 & CAIN3)	1762.99	1	1762.99	21.95	<.001
TRMNT X Time	178.72	1	178.72	2.23	.139

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score
TRMNT = Treatment group (relaxation or contol)

Table 13: Reduction of computer anxiety score (RCAS) by need for cognition (median split)

	CAIN1	CAIN3	RCAS (CAIN1 - CAIN3)
Low need for cognition	51.78	45.73	6.05
High need for cognition	58.76	53.24	5.52

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score
RCAS = Recuction in computer anxiety score (CAIN1 minus CAIN3)

Table 14: Differences in relaxation effects on achievement between lecture and lab portions of a computer literacy course

Descriptive Information	Mean	Standard Deviation	Maximum	Minimum	Range
Lab grades					
All Subjects	229.50	25.38	279	155	124
Relaxation Group	230.55	24.03	279	155	124
Control Group	228.59	26.69	274	159	115
Lecture grades					
All Subjects	103.07	13.01	128	68	60
Relaxation Group	102.38	13.47	127	68	59
Control Group	103.67	12.68	128	68	60

t Tests	Mean Scores	N	Degrees of Freedom	t	Significance
Lab grades					
Relaxation	230.55	47	99	.39	.70
Control	228.59	54			
Lecture grades					
Relaxation	102.38	47	99	.49	.63
Control	103.67	54			

Table 15: Correlation matrix, including CAIN1, CAIN2, CAIN3, RCAS, NCSS, LAB, LEC and GRADE

	CAIN2	CAIN3	RCAS	NCSS	LAB	LEC	GRADE
CAIN1	r = .68 p < .001	r = .76 p < .001	r = .41 p < .001	r = .17 p = .088	r = -.15 p = .119	r = -.11 p = .287	r = -.16 p = .114
CAIN2		r = .66 p < .001	r = .09 p = .366	r = .24 p = .015	r = -.16 p = .097	r = -.31 p = .002	r = -.24 p = .014
CAIN3			r = -.28 p = .004	r = .29 p = .003	r = -.30 p = .003	r = -.29 p = .004	r = -.33 p = .001
RCAS				r = -.16 p = .102	r = .19 p = .057	r = .24 p = .014	r = .23 p = .018
NCSS					r = -.03 p = .770	r = -.18 p = .071	r = -.09 p = .376
LAB						r = .51 p < .001	r = .94 p < .001
LEC							r = .77 p < .001

CAIN = Computer Anxiety Index (lower score = less anxiety)
CAIN1 = Precourse CAIN score
CAIN2 = Midcourse CAIN score
CAIN3 = Postcourse CAIN score
RCAS = Recuction in computer anxiety score (CAIN1 minus CAIN3)
NCSS = Need for cognition score
LAB = Lab score
LEC = Lecture score
GRADE = Total score (LAB plus LEC)

DISCUSSION OF RESULTS

This chapter contains seven sections. The first section will provide a review of the processes used in the study. The second section will discuss computer anxiety in relation to computer literacy training. It will explain findings relating to both the computer literacy course that was the treatment used in this study, as well as findings relating to subject's previous computer literacy training. The third section will examine the findings relating to the experimental treatment that was used in this study. The effects of relaxation exercises on computer anxiety and achievement will be discussed. The fourth section will deal with the personality variable "need for cognition." It was included as an exploratory component of the study. The relationships between need for cognition, and other variables in the study will be discussed. Achievement was also examined in relation to computer anxiety, in an attempt to expand the knowledge of the future effects on students of high levels of computer anxiety. The fifth section will discuss results relating to achievement and computer anxiety. The sixth section will propose directions for future research in the area of computer anxiety that were suggested by the results of this study, and the last section will offer a summary of the conclusions of this study.

Review of Processes Used in this Study

This study examined computer anxiety with respect to four main areas; computer literacy training, relaxation exercises, achievement (grades) and the personality variable "need for cognition." The subjects were college students in a semester long computer literacy course that was part of a teacher preparation program. Computer anxiety was measured using the Computer Anxiety Index (CAIN; Maurer, 1983). The CAIN was taken by students at three times in the semester, at the beginning of the course, after six weeks, and at the end of the course. Need for cognition was measured using the Need for Cognition

Scale (NCS; Cacioppo, Petty and Kao, 1984), and was taken by students during the second week of the class. Achievement was assessed using grades assigned in the class.

The students were also asked to participate in a relaxation exercise prior to each weekly lab meeting. A randomly selected group of students performed a short muscle relaxation exercise just prior to their lab class, and the remaining students were involved in a control procedure (they learned a new computer word each week).

The Effects of Computer Literacy Training on Computer Anxiety

One area of disagreement among researchers in the area of computer anxiety is the effect of experience with computers on computer anxiety (Rosen, Sears and Weil, 1987). Findings in this area have been mixed. A computer literacy course can be considered a type of structured experience. This study examined the relationship between computer literacy training and computer anxiety. This was examined in two ways, through subjects' participation in a computer literacy course, and by examining their previous computer literacy training.

Hypothesis 1 questioned whether students entering a computer literacy course with previous computer literacy training would have lower computer anxiety and it was found that experience was related to low levels of anxiety. This finding does not answer the question "does computer literacy training reduce computer anxiety?" A correlation does not establish cause and effect (Borg & Gall, 1989), and this relationship is further complicated by the fact that the subjects were voluntary participants in the class (the class was not required either for graduation, or for teacher certification). Previous research has suggested that computer attitudes were more positive in individuals who voluntarily participated in a computer oriented class (Hill, 1988; Slowiczek, 1988). Nevertheless, this finding is one piece of information in support of a relationship between experience and lower levels of computer anxiety.

Hypothesis 2 suggested that computer anxiety would be significantly lower after participation in a computer literacy course. This study supported this hypothesis. Considering that the stability over time of the CAIN has been established when there was no intervention (Maurer, 1983), this finding is an indication that computer literacy training can produce a reduction in computer anxiety. The results of this study do not suggest that any type of computer literacy course would be effective in reducing computer anxiety, but that one instructional situation did.

Hypothesis 4 proposed that individuals who had previous computer literacy training would have less reduction in computer anxiety than those who had not had computer literacy training. The purpose of this hypothesis was to further examine the notion that computer literacy training was effective at reducing computer anxiety. If computer literacy training is effective in reducing computer anxiety, then it would be expected that those who had previously experienced such training would also experience a reduction in their computer anxiety. Those individuals would little or no anxiety, and would have a less reduction than those who had no previous training.

This hypothesis was supported. There was a significantly different change in CAIN scores from the beginning to the end of the course for students who had previous computer literacy training and those who had no training. In other words, those with no previous computer literacy training had a greater reduction in computer anxiety than those who had previous computer literacy training.

Hypothesis 3 suggested that computer anxiety would not be significantly reduced after the first six weeks of the course. The concept being tested was that a significant amount of time was necessary to change an attitude, specifically computer anxiety. A previous study (Honeyman & White, 1987) found that computer anxiety was not reduced in the first six weeks of a computer literacy course, although it was significantly reduced over the course of a semester. That finding was replicated in this study.

This helps to explain some of the conflicting results that have been reported with respect to computer literacy training and reduction of computer anxiety (e.g., Weil, Rosen, & Sears 1987; Honeyman & White, 1987; Mackowiak, 1988; Koohang, 1987). Studies that reported no change in computer anxiety resulting from participation in a computer literacy course may not have had sufficient time in the course to produce a significant, positive change. A post hoc correlation between midcourse computer anxiety and change in computer anxiety (from the beginning of the course to the end) found a very low correlation ($r = .09$; see table 15).

One other surprising outcome of the Honeyman and White study was that there was actually a slight rise (not statistically significant) in the anxiety of individuals who had previously taken a computer literacy course in the first six weeks. The same pattern was found in this study (see Figure 1). Individuals who had previously taken a computer literacy course had an average rise of 3.66 points on the CAIN from the beginning to the middle of the course. Individuals without previous computer literacy training had virtually identical scores in the middle of the semester as they did at the beginning of the course. Although this finding could be attributed to measurement error, two studies produced very similar results. This is sufficient reason to propose possible explanations, and to examine the finding further.

One possible explanation for this slight rise in computer anxiety could be anxiety due to conflict between information and skills being acquired in the new course with the older information and skills from the previous course. In their previous computer literacy course, the students learned certain processes, and information was presented in a certain way. It is almost certain that the processes and information in the course examined in this study were different from those in the previous course. This could potentially cause anxiety in the students who were having to resolve the procedural and informational conflicts. Later in the course, as the processes and information becomes more "comfortable" for the students, their anxiety was lowered. On the other hand, students with no previous computer literacy training would not have these conflicts to resolve.

Relaxation Effects

Another topic that this study examined was the effect of relaxation exercises on computer anxiety and achievement in a computer literacy course. Hypothesis 5 proposed that engaging in relaxation exercises just prior to each lab would significantly reduce computer anxiety at the end of the course. This hypothesis was not supported by the data gathered in this study. Although the relaxation group did experience a decrease in anxiety that was greater than the control group, this difference was not statistically significant.

After examining the information related to anxiety change over the course, and with respect to previous computer literacy training, it was decided that a post hoc (after the fact) test might provide additional information. The results from tests of hypothesis 1 and 2 suggested that it was possible that the group with previous computer literacy training were involved in a ceiling effect (Borg & Gall, 1989, p. 729). Therefore, the effects of relaxation on only individuals who had not previously had any computer literacy training were examined. This was to determine if that group of individuals would significantly benefit from the addition of relaxation exercises to a computer literacy course. The post hoc hypothesis was: when only considering individuals who had not previously taken a computer literacy course, those who participated in relaxation exercises would have significantly lower postcourse computer anxiety than those who did not participate in relaxation exercises.

The first step in this analysis was to examine the average change scores for the two groups (relaxation and control) of students, including only those who had not previously taken a computer literacy course (see Table 16). It appeared that relaxation almost doubled the effect that was produced by the course alone. In other words, the change in computer anxiety for the relaxation group was almost twice the change of the control group. To test this post hoc hypothesis, the effect was examined using a repeated measures analysis of variance technique, with CAIN1 and CAIN3 being used as the repeated measures and participation in the relaxation or the control group as the independent variable (using as subject, the "no previous computer literacy training" students only).

The change over time between the relaxation and control groups for students who had not previously taken a computer literacy course was not significant (see Table 17). This result seemed contrary to what the raw numbers would suggested, however. Inspection of the standard deviations of the reduction of computer anxiety scores (RCAS) for the students who had not previously taken a computer literacy course (see Table 16) helped explain the lack of statistical significance. There was much more variability involved with the RCAS of the relaxation group than there was with the control group. The RCAS scores have been grouped and presented in a bar chart to more clearly depict the differences in the variability of scores (see Figure 2).

Hypothesis 12 suggested that the relaxation treatment would have a greater effect on achievement in the lab portion of the course than on the lecture portion of the course. It was assumed that the lab grades and lecture grades were measuring different kinds of learning. Although this assumption was not directly tested, there is evidence in support of that assumption. If these two grades were measuring the same learning, then they would be highly correlated . "Correlation coefficients over .85 indicate a very close relationship between two variables correlated (Borg & Gall, 1989, p. 632)." The correlation between the lecture and the lab grades was .51 ($r = .51$). This was a significant correlation, as would be expected. The strength of the correlation however, was much less that would be expected between two measures of performance in the same course. This correlation indicates that the two grades had only 26% shared variance ($r^2 = .26$). That would tend to support the assumption that lab grades and lecture grades were measuring different kinds of learning.

Another assumption that was made in conjunction with hypothesis 12 was that relaxation would reduce anxiety and that that reduced anxiety would have a greater effect on performance in lab. First, the lab immediately followed the relaxation exercises, so students would be more relaxed in the lab. Second, the lab required direct interaction with the computer, a situation that could potentially heighten feelings of anxiety. There was no significant difference between the achievement scores of the relaxation group and the control group in either the lab or the lecture portion of the course.

It was concluded that relaxation just prior to a hands-on learning experience with computers did not improve achievement on subsequent hands-on tasks. Although this finding indicates that relaxation is not effective, it is possible that there was an effect of relaxation on performance that was not measured in this study. The lab grades were determined by judging assignments, most of which were completed as home-work. Most of the assignments were not performed in the lab after the relaxation exercises. A new study that measured performance immediately after the relaxation exercises might produce different results.

Need For Cognition and Computer Anxiety

One surprising finding of this study was the relationship between the personality variable "need for cognition" and precourse computer anxiety. Hypothesis 6 proposed that these two constructs would be negatively related, that is, those with a high need for cognition would have lower computer anxiety, and those with a low need for cognition would have high computer anxiety. It was hypothesized that individuals with a high need for cognition would naturally "take to" computers because of their desire to use a cognitive enhancer (the computer). The correlation between need for cognition and computer anxiety was not found to be significant at the .05 level, but the surprising finding was the direction of the correlation ($r = .17$). The relationship between these two variables was positive.

Although this finding ran counter to what had been proposed, one possible explanation was previously reported in a study using the Need for Cognition Scale that examined attitude-behavior consistency. Cacioppo and his colleagues found that low need for cognition individuals are more easily persuaded than high need for cognition individuals (Cacioppo, Petty, Kao, & Rodriguez, 1986). It is possible that the low need for cognition students in this study had already been persuaded to have positive attitudes towards computers.

The second finding relating to need for cognition was as predicted in hypothesis 7, which proposed that need for cognition would be related to change in computer anxiety. There was a significant, positive correlation ($r = .26$) between need for cognition, and postcourse computer anxiety, after the effects of precourse computer anxiety had been partialed out. Individuals who had higher need for cognition tended to have higher computer anxiety at the end of the course. Low need for cognition individuals had a greater tendency to improve their attitude (i.e., to lower their computer anxiety), than did high need for cognition individuals. This is consistent with much of the research that has been reported using the Need for Cognition Scale (Cacioppo, Petty, Kao, & Rodriguez, 1986; Cacioppo & Petty, 1982).

On first examination, this finding may seem significantly useful, but on further inspection, there are problems with applying this finding to an instructional situation. It is hoped that improvements in attitudes (e.g., a lowering of computer anxiety) translate to some sort of improved behavior. Individuals with lower computer anxiety should behave more positively with respect to computers (e.g., more efficiently, more successfully, more effectively). The work of Cacioppo and colleagues found a complication with this relationship when considering need for cognition (Cacioppo, Petty, Kao, & Rodriguez, 1986). They found behavior and attitudes to be more closely related in high need for cognition individuals than in low need for cognition individuals, which suggests that the greater improvement in attitude experienced by low need for cognition individuals may not translate into a corresponding improvement in behavior with respect to computers. This finding in conjunction with the fact that the correlation between these two measures (NCS and postcourse CAIN) was small, made it doubtful that the relationship was indicative of a significant behavioral change with respect to computers. To state this in another way, those subjects who had low need for cognition may have had a greater reduction in their computer anxiety score than the high need for cognition subjects, but it was unlikely that their behavior towards computers improved any more than the high need for cognition subjects.

Achievement and Computer Anxiety

The effects of computer anxiety and computer anxiety reduction on achievement were an important part of this study. Although much has been proposed about the effects of computer anxiety, very little has been established through research. Hypothesis 8 proposed that there would be a negative relationship between precourse computer anxiety, and final grades in a computer literacy course. Although the relationship that was found between these two variables in this study was negative, it was too small to be statistically significant ($r = -.16$, $P = .114$; see Table 15). It is possible that the relationship between precourse computer anxiety and achievement existed, but this study showed that that relationship was a weak one at best. This was an important finding, because a number of authors and researchers have suggested that computer anxiety negatively affects an individual's future.

Hypothesis 9 proposed that postcourse computer anxiety was negatively related to the final grade in a computer literacy course. This hypothesis was supported by the data gathered in this study. This suggested that the postcourse computer anxiety was significantly more important in relation to final grade than was precourse computer anxiety. The results of hypothesis 10 found that the correlation between CAIN1 and GRADE was significantly different from the correlation between CAIN3 and GRADE. They were found to be significantly different. This indicated that the relationship between postcourse computer anxiety was more strongly related to course grade than precourse computer anxiety. Although the establishment of a cause and effect relationship between these two variables was not part of the design of this study, either of the two most likely reasons for this relationship are interesting ones. When the results of hypothesis 10 are coupled with the results of hypothesis 1 (anxiety is reduced over the course of the semester), an interesting research question for the future emerges: "Does reduced anxiety improve achievement, or does improved achievement reduce anxiety?"

Hypothesis 11 suggested that the relationship between change in computer anxiety and lab grade would be stronger than the relationship between computer anxiety and lecture grade. This hypothesis was based on the ideas proposed by Anderson (1983) that stated that knowledge can be either primarily declarative or primarily procedural. This theory fit nicely with the design of this course. The course consisted of two parts, a lecture portion, and a lab portion. Although these two parts were closely related, they were delivered separately (at different times, and with different instructors) and they were evaluated separately. The lecture portion was mainly lecture and demonstration and paper and pencil methods of evaluation were used. It was felt that the lecture grade would be more an indication of declarative knowledge.

The lab portion of the course was mainly hands-on execution of procedures and was assessed by evaluating products of hands-on oriented assignments and a hands-on midterm exam. It was felt that the lab grade would be more an indication of procedural knowledge. Hypothesis 11 tested the idea that computer anxiety was more strongly related to acquisition of procedural knowledge than to the acquisition of declarative knowledge.

The findings of this study did not support this hypothesis. The correlation between computer anxiety and lab grades and correlation between computer anxiety and lecture grades were not significantly different . In fact, the correlation between lecture grade and computer anxiety was slightly stronger ($r = -.31$) than the correlation between lab grade and computer anxiety ($r = -.28$).

This could be partially explained by the fact that it is impossible to cleanly separate procedural knowledge and declarative knowledge (e.g., lecture exams included questions like program debugging that required the execution of procedures, and lab exercises often involved the recall of declarative information). However, since as was mentioned earlier, it appears that lab and lecture grades measured different things, it seems unlikely that this avenue of investigation would be fruitful.

Suggestions for Future Research

The relaxation exercises were not shown to be significantly effective, but the data was not discouraging. The average anxiety change of the individuals in the relaxation group was almost twice the change of the control group. One factor that contributed to the lack of statistically significant impact of the relaxation exercises was the variability of the CAIN scores of the individuals involved in the relaxation exercises. This may have indicated methodological problems with the relaxation procedures. It could also indicate that relaxation is highly effective with some groups, and less effective with others. These are questions that need further exploration.

One specific way that the relaxation procedures could be enhanced would be to use some form of direct link between the relaxation and anxious situations involving the use of computers. In this study, the link between relaxation and computer anxiety were implied rather than direct. Students participated in a relaxation exercise, and then they went to their lab and used computers. If the relaxation exercises could be directly linked to anxious situations while using computers, the effect of relaxation could be enhanced.

Another aspect that could be explored in the future would be to include other aspects of a systematic desensitization program, like developing an anxiety hierarchy for computers, and taking students through a desensitization process using that hierarchy. That was not attempted in this study because one of the goals of this study was to examine techniques that could be used in a typical instructional situation. A full systematic desensitization program would be more in the arena of clinical psychology rather than instruction.

A third area that would be useful to examine would be the components of the instructional situation. The course used in this study included lectures, demonstrations, hands-on guided practice, hands-on independent work, availability of help, opportunities to work with peers and numerous other features that could have contributed to the reduction of the computer anxiety, or that conversely could have served to increase anxiety. The examination of each of these features independently would be helpful in designing a computer literacy course or curriculum that would be "tuned" for computer anxiety reduction.

A fourth area of future research that would be very useful, and at the same time very difficult to design, would be to look at the quality of instruction in relation to computer anxiety reduction. It is possible that computer anxiety was lowered in this study because of the quality of the computer literacy course. This type of research has not been reported probably because of the difficulty of designing poor instruction into an experiment. However, if it were possible to use quality of instruction as an independent variable in an examination of reduction of computer literacy, it could provide some valuable information.

Fifth, information about personality variables in relation to computer anxiety need further investigation. The results relating to the personality variable "need for cognition" in this study were unfortunately of limited value. This information, coupled with much more personality related information could be of significant use to individuals interested in designing effective instruction. To do this, it is necessary to know what sort of individuals respond best to what sort of instructional situation. This would be in concert with current research directions in the area of cognitive psychology. A research study that examined the relationships between the various subscales of the Minnesota Multiphasic Personality Inventory, a measure described as "the most widely used inventory of all time" (Levitt, 1980, p. 29), could provide significant information about the relationships between computer anxiety and other personality traits.

Last, it would be interesting to know more about the future effect of high levels of computer anxiety. Many individuals are making statements about the effects of negative attitudes towards computers, but there is virtually no longitudinal information available to support such claims. This study showed that computer anxiety can be modified by and instructional experience. A study that examines the change in computer anxiety over an extended period of time, and relates anxiety to aspects of an individual's life (e.g., career possibilities, promotion, salary, opportunities to take advantage of emerging technologies in the home) would help to either establish this hypothetical relationship, or refute it.

Summary

From the data gathered in this study, there was significant evidence found that supported the position that computer literacy training was an effective means of reducing computer anxiety. This study discovered a significant, but weak relationship between the personality variable "need for cognition", and reduction of computer anxiety. Last, this study found that the relationship between computer anxiety and achievement in a computer literacy course was more strongly related to the postcourse computer anxiety than it was to precourse computer anxiety

Table 16: RCAS scores for subjects by experimental treatment group and previous computer literacy training

	No Previous Training			Previous Training		
	RCAS Mean	Standard Deviation	N	RCAS Mean	Standard Deviation	N
Experimental subjects	14.87	20.42	15	4.50	10.25	32
Control subjects	7.82	7.37	17	2.30	11.16	37

CAIN = Computer Anxiety Index
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score
RCAS = Reduction in computer anxiety score (CAIN1 minus CAIN3)

Table 17: Repeated measures analysis of variance comparing treatment groups (relaxation or control; TRMNT), over time (CAIN1 and CAIN3), for only those with no previous computer literacy training (N = 32)

	Sums of Squares	DF	Mean Squares	F	Significance
TRMNT	320.21	1	320.21	.52	.477
Time (CAIN1 & CAIN3)	2051.34	1	2051.34	18.35	<.001
TRMNT X Time	197.65	1	197.65	1.77	.194

CAIN = Computer Anxiety Index
CAIN1 = Precourse CAIN score
CAIN3 = Postcourse CAIN score
TRMNT = Treatment group (relaxation or control)

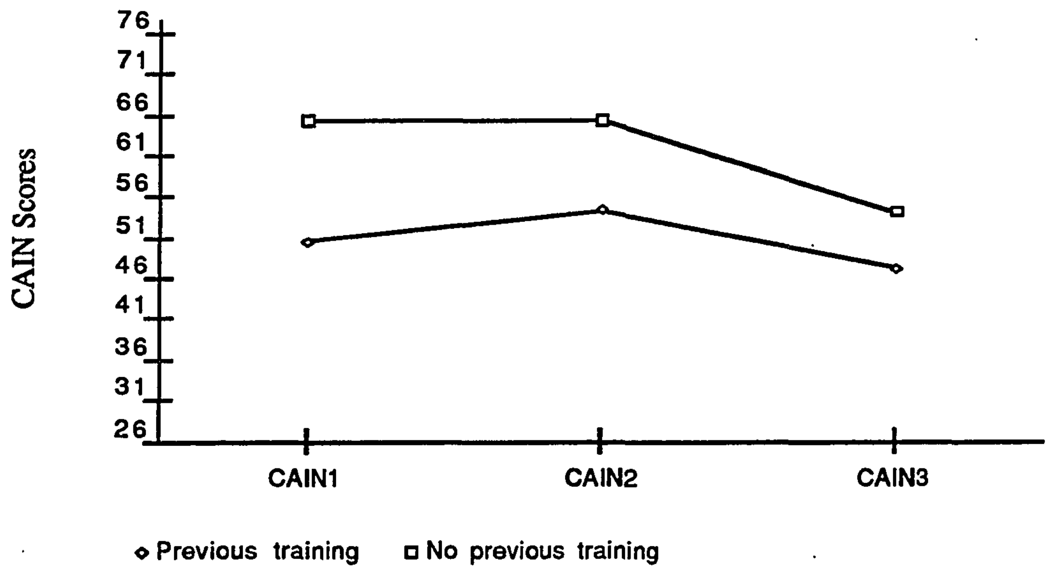

Figure 1: Comparison of CAIN scores (CAIN1 = Precourse, CAIN2 = Midcourse and CAIN3 = Postcourse) for subjects with previous computer literacy training and subjects without previous computer literacy training

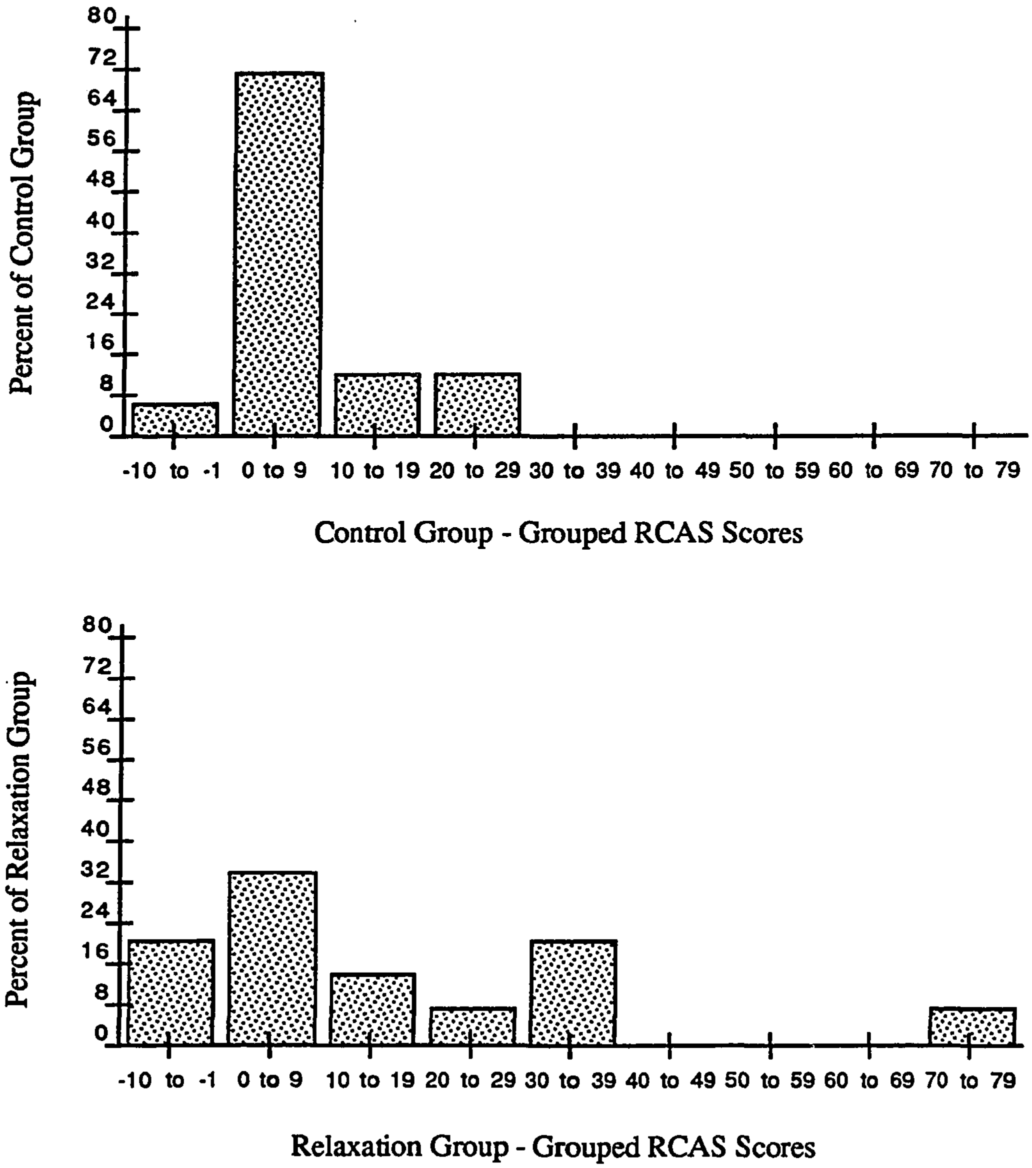

Figure 2: Comparison of relaxation group and control group reduction in computer anxiety scores (RCAS) only including subjects who had no previous computer literacy training

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AKCNOWLEDGEMENTS

Many people were very helpful to me in completing this project. The first on my list is Dr. Michael Simonson. His exacting standards forced me to do better work than I might have done otherwise, and I truly appreciate that. I also received some nice encouragement, suggestions, and help from each of my committee members. Thanks to Dr. Mary Huba, Dr. Rex Thomas, Dr. Gary Phye and Dr. Ann Thompson. I derived significant support from many of my fellow graduate students, and I thank them all for that support.

I would also like to thank those one hundred and one students who were my subjects for this project. Being a "subject" is something that many students experience in their college career, and I am not sure they are properly appreciated. Thank you, and remember that it is through your willingness to participate in experiments that new knowledge is created.

My warmest thanks goes to my family, for bearing with me while I completed my goal. Thanks Ben and Joe for sticking with me through the crabby times (like those several times when you turned off my computer while I was working). I am not sure I would have finished without those preiodic reminders of what is really important (like getting a drink of water when you are thirsty). Thanks Joe for keeping me company on those many late night evenings when I was learning statistics. Somehow, having a 2 year old on my lap made the unpleasant experience of mastering various statistical procedures a bit more bearable. Thanks Ben for awarding me the "PhD" that came from Publisher's Clearinghouse, and reminding me that it is just a piece of paper.

My deapest and most heartfelt thanks go to my wife, Carol Bowman. Thank you for going along with me on this crazy adventure, and thank you for your own personal kind of support. In my life with you, it will be difficult for my ego to get too terribly out of

control. Upon the completion of this project, which is my "final final project" in my many years of formal education, I am reminded of something a wise man once said, "one of the true tragedies in life and love is when the important things get overlooked in pursuit of the minor details" (Maurer, 1983, p. 65).

APPENDIX A.

COMMUNICATIONS WITH SUBJECTS AND USE OF HUMAN SUBJECTS FORM

Initial Letter to Research Subjects

Secondary Education 101 Students:

During the course of this semester, an experiment will be conducted for the purpose of improving instruction related to computers. This experiment will require five minutes of your time at the beginning of each lab period. Beginning next week, your labs will be split, and some of you will be asked to assemble in room N045, while the rest will meet in the classroom (E006). The nature of the experiment can not be completely explained at this time because such an explanation would strongly bias the results of the experiment. A full explanation will be provided at the end of the semester. We ask that you not discuss the nature of the processes that take place in the first five minutes of lab, since that too would bias the results of the experiment.

This experiment will not involve any discomfort or risk to you physically, nor any disadvantage to you academically. In addition, any information related to individuals collected in this study will be kept in confidence, and will only be reported as an amalgam of the whole class. Your right to confidentiality will be strictly protected.

Your participation is purely optional, and you can choose to withdraw from the experiment at any time. Declining to participate or withdrawing from the experiment will not effect your grade in the class in any way. However, your participation will help us develop techniques that you as a teacher may be able to use to improve instruction, so your participation is strongly encouraged. If you choose not to participate, or if during the semester, you choose to withdraw from the experiment, please let your lab instructor know, so you can be identified in the study as a non-participant. If you choose to participate, it is important that you arrive promptly for lab, since one important process takes place during the first five minutes of the lab.

You will be given full information on this study at the end of the semester. Thank you for your participation.

May 13, 1991

101 students:

Thank you for your participation in this study this semester. It is too early to tell you what the results have been, since the data has not yet been fully analyzed.

The intent of this study has been to discover if a short relaxation process performed just prior to the use of computers would have any effect on computer anxiety. Half of the students relaxed before lab (experimental group) and half the students didn't (control group). The control group performed what might be called a null procedure, which consisted of getting an explanation of the "computer word of the day."

Your computer anxiety was measured in lecture with the "Computer Opinion Survey", at the beginning of the semester, at midterm, and at the end. You were also given the "Need for Cognition Scale" at the beginning of the semester. This will be compared to the results of the relaxation experiment, to see if differing results on this instrument relates to differing results in terms of your change in computer anxiety.

The last thing that will be looked at in this study will be your course grade. Your course grade will be compared to your computer anxiety, your change in computer anxiety, and participation in the relaxation procedure. Again, please remember that none of this information will be reported for you as an individual, but only as part of the whole class, so your confidentiality will be strictly protected.

Thanks again for your participation, and have a good summer!

Sincerely,

Matt Maurer

Last Name of Principal Investigator Maurer

Checklist for Attachments and Time Schedule

The following are attached (please check):

12. [X] Letter or written statement to subjects indicating clearly:
    a) purpose of the research
    b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see Item 17)
    c) an estimate of time needed for participation in the research and the place
    d) if applicable, location of the research activity
    e) how you will ensure confidentiality
    f) in a longitudinal study, note when and how you will contact subjects later
    g) participation is voluntary; nonparticipation will not affect evaluations of the subject

13. [ ] Consent form (if applicable)

14. [ ] Letter of approval for research from cooperating organizations or institutions (if applicable)

15. [X] Data-gathering instruments

16. Anticipated dates for contact with subjects:

First Contact	**Last Contact**
1/28/91	5/15/91
Month / Day / Year	Month / Day / Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

5/1/91
Month / Day / Year

18. Signature of Departmental Executive Officer: [signature] Date: 1-10-91 Department or Administrative Unit: Professional Studies

19. Decision of the University Human Subjects Review Committee:

X Project Approved ___ Project Not Approved ___ No Action Required

Patricia M. Keith — Name of Committee Chairperson
1/17/91 — Date
PM Keith — Signature of Committee Chairperson

APPENDIX B.

RELAXATION EXERCISES
(Beech, Burns, and Sheffield, 1982, p 48-53)

RELAXATION EXERCISES
(Beech, Burns, and Sheffield, 1982, p 48-53)

Week 1, 6 and 11 - Arms

Sit back in your chair as comfortably as possible, breath in and out normally, close your eyes and relax - relax completely.
Keep relaxed but clench your right fist.
Make the muscles of your lower arm and hand even tighter.
Monitor the feelings of tension.
Now relax; let all the tension go.
Allow the muscles of your lower arm and hand to become completely limp and loose.
Notice the contrast in the feelings.

Again clench your right fist - tighter and tighter
Hold the tension and monitor the feelings.
Relax. There should be no signs of tension in your hand or lower arm.
Notice the feelings of relaxation again.

Keeping your right hand and lower arm as relaxed as possible, bring your right elbow into the back of the chair and press downwards, contracting the bicep muscles (between your elbow and shoulder).
Press harder: make the muscles more tense.
Monitor the feelings of tightness.
Relax. Now let the tension dissipate immediately.
Observe the difference. Let the muscles relax further.

Now tense the right biceps again.
Make the muscles harder, tighter, more tense.
Monitor the feelings of tension.
Relax. Let the tension go completely.

Concentrate on the whole of your right arm. Relax it now, more and more deeply; relax it further and further.

(Repeat exactly for the left arm.)

Week 2, 7, and 12 - Face, and Neck

Focus on your forehead muscles.
Raise your eyebrows upwards (keeping your eyes closed) and wrinkle your forehead.
Wrinkle it tighter. Hold it. Monitor the feelings.
Relax; smooth it out; let the tension go completely.
Now contract the forehead muscles - raise the eyebrows, frown, wrinkle the muscles.
Study the feelings of tension.
Release; smooth the forehead muscles.
Observe the pleasant feelings of relaxation in the muscles.

Pay attention to your eyes, upper cheeks and nose.
Squint the eyes tightly; wrinkle the nose.
Hold it.
Scrutinize the tension feelings.
Release the tension.

Examine the feelings of relaxation - allow the muscles to become even more deeply relaxed.
Once again, tense the eyes, upper cheeks and nose.
Now make the muscles considerably more tense.
Reflect on the feelings of tension.
Relax totally.

Now concentrate on your jaws and chin.
Clench your haws; bite your teeth; pull the side of your mouth outwards.
Press your tongue hard against the roof of your mouth.
Look for the tension.
Relax. Appreciate the feelings of relaxation.
Now tense jaw, chin and tongue again - make the muscles more and more taut.
Release the tension; loosen the muscles completely.
Observe the feelings of relaxation.

Now focus on the whole of your face.
Allow all the muscles to become more and more deeply relaxed. No signs of tension; no signs of firmness.
Let the relaxation develop; let it grow deeper and deeper.

Now concentrate on the neck muscles.
Press your head firmly against the wall.
Press back with more force, making the muscles more and more taut.
Monitor the feelings of tautness.
Relax. Let the tension dissipate completely.
Discriminate the feelings of relaxation from those of tension.
Repeat the exercise tensing the neck muscles.
Again, perceive the feelings of pressure.
Relax - let it go.
Monitor the enjoyable sensation of relaxation.

Week 3, 8, and 13 - Shoulders, chest, lower back and stomach

Relax your whole body completely.
Take a slow deep breath.
While holding the breath, sit forward slightly, throw the chest out and bring the shoulder blades together, keeping the hands relaxed.
Hold, and monitor the tension.
Relax. Exhale. Drop into the chair; let the tension go completely.
Notice the feelings of relaxation while breathing in and out normally.
Once again take a slow deep breath, sit forward, throw the chest out and bring the shoulder blades together.
Again observe the feelings of tightness.
Relax. Exhale. Let your body slump into the chair.

Breath in and out normally.
Enjoy the relaxation feelings.

Concentrate on the stomach muscles.
Pull the muscles in, tightly.
Survey the feelings of tension.
Relax. Let the muscles become flaccid.
Scan the feelings of relaxation. Study them.
Draw the muscles of the stomach in.
Examine, once more, the feelings of tautness.
Now relax; let all signs of tension go.

Focus now on the whole of the main part of your body - shoulders, chest, stomach, back.
Let the whole of this area become more and more relaxed. Give in to the feelings of relaxation compieteiy Don not resist them. Allow yourself to become more and more deeply relaxed.

Week 4, 9, and 14 Legs and feet

Press your right heel into the floor. Press it down harder.
Notice the feelings of tension in the thigh.
Study that tension.
Relax. Keep relaxing. Monitor the relaxation.
Again, press your right heel into the floor.
Again, scrutinize the tense feelings.
Relax again. Let the tense feelings dissipate.
Reflect on the pleasant feelings of relaxation now.
Focus on the right calf.
Tense the muscles by curling the toes of your right foot downwards.
Make the muscles more tense.
Recognize the feelings of the rigid muscles.
Now let the feelings go. Just relax.
Again tighten up the calf muscles by curling the toes downwards.
Hold and observe the tense feelings.
Relax. Enjoy the feeling of comfort.

Concentrate on your right foot.
Tense it, by curling your toes upwards.
Have the muscles become more and more taut.
Monitor the feelings.
Relax. Let all the tension go out of the muscles.
Now flex your foot muscles again by curling your toes upwards.
Study the tension.
Let the tension go.
Notice how relaxed the foot muscles feel.

(The left leg and foot are relaxed in the same manner.)

Week 5 and 10 and 15 - Whole body

Sit down and relax fully.
Concentrate on your whole body - head, neck, shoulders, chest, stomach, lower back and legs.
Let our whole body sink into an even deeper state of relaxation.
Just give in to the feelings of relaxation. Do not resist them.
Allow your whole body to become more and more relaxed.
Continue to breath in and out normally.
Concentrate on your legs. Visualize that they are becoming more and more heavy; more and more relaxed.
Imagine the heaviness spreading into your stomach and chest regions; now into your neck and head.
Your hands and arms are becoming heavier, more and more relaxed.
Your whole body is becoming heavier and heavier.
Becoming so heavy now that its sinking into the chair, down, down, down, becoming more and more heavy more and more relaxed.
Monitor the very pleasant feelings of deep relaxation; feelings of calmness and tranquility.
Keep your thoughts on these feelings.
Just continue to relax.
(have students sit and relax for one full minute in silence.)

APPENDIX C.

WORDS OF THE WEEK: CONTROL GROUP ACTIVITIES

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Initial instructions - Word of the week

This group will be doing a computer vocabulary exercise, called "the word of the week" before each lab. We will be introducing a new word each week throughout the semester. The idea here is that we believe that it may help you work better in your lab if you have a better command of the terminology. So before each lab, an instructor will introduce a new word, define it and use it in a sentence. We would like you to remember to use the word whenever it would be appropriate to do so throughout the week.

Week 1 - word of the week - CPU

The word of the week is not really a word, but an acronym. It is CPU. CPU stands for central processing unit. The central processing unit is the element of a computer that actually does the computation. You could say that it is the "brains" of the computer. In a microcomputer, the CPU is usually contained on a single silicon chip. The speed of the CPU is one critical factor in determining the power of your computer. Using CPU in a sentence, you could say, "my computer has a very fast CPU," or you could say, "the CPU is inside the box we usually call the computer," or "the CPU does computation", or "which chip inside this machine is the CPU?"

Week 2 - word of the week - bit

The computer word of the week for this week is bit. In the context of computers, bit is a shortened form of the phrase "binary digit". A bit is the smallest unit of data in a computer. It usually takes eight bits to represent a single letter, number of special character, like a dollar sign, or an exclamation point. Bits are represented on a floppy disk as small areas of magnetism. A floppy disk can store hundreds of thousands or even millions of bits. Any time data is transferred or stored in a computer, the data is represented as a collection of bits.

To use the word bit in a sentence, you could say, "all information in a computer is made up of a group of bits", or "a floppy disk can store a very large number of bits," or "if my bits get mixed up, my data will be scrambled."

Remember, the word of the week is bit. Remember to use it when ever you have a reasonable opportunity to do so throughout the week.

Week 3 - word of the week - Byte

The word of the week this week is byte. Although is sound just like the word spelled b-i-t-e, byte in a computer context is spelled b-y-t-e. A byte is a unit of data. In most cases, a byte is equavalent to a single letter, number, or special character. So the letter "a" would be an example of a byte, as would be the number "5", or the symbol for an asterisk. As a follow up to last week's word, "bit", bytes are made up of bits. With most computer systems, there are 8 bits in a byte.

To repeat, a byte usually represents a single letter, number or special character. The word red, r-e-d would be 3 bytes long, and the word black would be 5 bytes long, while the word yellow would be 6 bytes long.

To use the word byte in a sentence, you might say, "it is important to remember that even though a space looks like nothing on the screen, it still takes up one byte in the computer," or you could say, "it takes 8 bits to make a byte," or "how many bytes are in your last name."

It is said that to be a computer programmer, you have to know your bits and bytes.

Week 4 - word of the week - RAM

The word of the week this week is another acronym. Acronyms are very common in the comuter field. An acronym is a group of letters that substitute for a group of words. So the acronym of the week is RAM or R-A-M. RAM stands for Random Access Memory. RAM is the kind of memory inside your computer, as opposed to the kind of memory on a disk.

One important thing to know about RAM is that if you turn you computer off, RAM is erased. That is why your lab instructors often tell you to save your information. As a matter of fact, if the machine looses power (say someone kicks your plug, or there is a power outage), your RAM will be erased, and you will lose all your work.

Another important thing to know about RAM is that the amount of RAM in a computer is another measure of how powerful your computer is. If you're computer has a lot of RAM, it is more powerful than if it has only a small amount of RAM. New computers today commonly come with 1 megabyte, or one million bytes, of memory or more.

To use RAM in a sentence, you could say, "how much RAM does this computer have?" or, "have you saved your information from RAM to your floppy disk?"

Remember, the word of the week is RAM. Remember to use it when ever you have a chance throughout the week.

Week 5 - word of the week - ROM

Last week's word was RAM, R-A-M, for random access memory. This week's word is ROM, R-O-M, for read only memory.

ROM is memory that is built into a computer, and it is not available to you as the user. The information stored in ROM is static, meaning it doesn't ever change.

The purpose of ROM is to give the computer instructions about how to operate. Things like start-up procedures are stored in ROM. Quite often, information about how to interact with peripheral devices, such as printers or disk drives is also stored in ROM.

The difference between RAM and ROM can be confusing, but an analogy may be helpful in clarifying the difference. RAM can be thought of as memory like the memory of an animal. Information is added, and information is lost as the animal learns and forgets. ROM on the other hand, could be thought of as the instinct of that animal. It contains information that is "built in", and the information is never changed, neither added to, nor subtracted from.

To summarize, the word of the week is ROM, R-O-M for read only memory. To use ROM in a sentence, you might say, "my computer won't boot up, so I suspect the ROM is damaged," or you could say, "I don't really care how much ROM my computer has, since I can't access it anyway."

Please remember to use the word of the week when you have an opportunity, ROM, which is short for read only memory.

Week 6 - word of the week - Edit

The word of the week this week is edit. You have certainly come across the word edit before, and it is no doubt part of your vocabulary. However, in a computer context, this word takes on a slightly different meaning.

Editing of course relates to making changes to information. In a non-computer context, it usually refers to the process of identifying changes that need to be made. For instance, a newspaper editor would read a story, and tell the reporter or type setter, where changes need to be made.

In a computer context, editing refers to the actual process of making those changes, not merely identifying the changes. So when you see that you have misspelled a word, and you change it, the process of changing the letters is editing. In a computer context, you not only edit words, but you can edit other sorts of things also. If you drew a picture like you did a couple of weeks ago with the Macintosh, and you later wanted to change it, the process of changing the picture would also be referred to as editing.

Another common use of the word edit that you are undoubtedly familiar with is related to shortening. Someone might tell you to "edit your remarks at a meeting", meaning to keep it short, and cut out anything that is not necessary. In a computer context, if you did that to a document, that would be considered editing, but adding information would also be considered editing. Any time you add, delete or change information in a document using a computer program, you can say you are editing that document.

The word of the week this week is edit. To use it in a sentence, you could say, "I need to get into the lab to edit my sign for the party, the map has an error," or you could say, "using a spell checker is an easy way to do some of the editing for my final draft."

Week 7 - word of the week - track

The word of the week this week is track. Tracks can be found in many different places, but in the world of computers, tracks are found on disks.

You may have wondered how data is put on a disk. Is it just all spread out on the disk, or is it organized some special way. Well you probably guessed that it is organized, and that organization relates to the word of the week. The data on a disk is recorded in concentric circles. These circles are called tracks. When you format a disk, you are defining the location of the tracks on a disk.

Disks have a number of tracks on them. Generally speaking, the more tracks that a disk has, the more data can be stored on it. Older disk drives were not capable of reading or writing tracks as close together as the disk drives we have today, so older disks usually have fewer tracks than more current disks. A typical number of tracks on a disk is from a few dozen to a few hundred.

To use the word of the week in a sentence, you might say "how many tracks are on that floppy disk?" or "my old apple disks have 40 tracks, and my newer IBM disks have 80 tracks on each side" or you could say "all the tracks on my disk are circular."

The word of the week is track. Remember to use it during the week when you have the opportunity.

Week 8 - word of the week - sector

Last weeks word was track. As you recall, a track is a circle of data, and there are many concentric circles of data on a floppy disk. The word of the week this week is sector. A sector is a portion of a track. If a track is a circle, then a sector is an arc. Tracks are divided into sectors so the disk drive can more easily locate any particular piece of information that may have been called for.

You may wonder why a track would have to be divided any further. Disks have so much information on them, that it is important to subdivide it for two reasons. The first is to make the data easier to physically locate, and the second it to allow the data to be put into managable chunks for the purpose of transfer from the disk to RAM.

If you try to picture a disk, and the tracks on that disks, you would see a little platter, with lots of concentric circles. If you picture a sector marker as a cross hatch in each of the tracks, then you can envision the disk as being divided into a number of pie shaped wedges. The typical number of sectprs that a track is divided into is from around 8 to a few dozen. So if you add up all the sectors on all the tracks, you will find that most disks have hundreds of sectors on them.

To use the word in a sentence, you could say, "some of my data was lost, because I had a bad sector on my disk" or "how many sectors per track does that disk have?" or "there sure are a lot of sectors on this disk".

Week 9 - word of the week - Icon

The word of the week this week is icon, spelled i - c - o - n. An Icon a symbol, usually a picture that conveys a specific meaning. Icons have been used since the early days of the human race. Examples include pictures of horses to represent real horses, or stick figures to represent people. In a computer context, icons are usually small pictures on the screen that visually represent some physical object, or logical construct. Icons are heavily used in more visually oriented computer systems, such as the Macintosh. Examples of icons would include the picture of the disks and files that appear on the screen when you turn on the Macintosh. The disk icons are pictures that represent the physical disk that is in the computer. The file Icons are pictures that represent the logical organization of the information on your disk.

You could use the word icon in a sentence by saying "to get to the programs on your disk, you must first double click on the disk icon", or you could say, "I have never seen that icon before, and I don't know what it means", or you could say, "I like computer systems that use icons, because I am more visual that verbal."

So, the word of the week is icon, a symbol, usually a picture that represents some physical object, or logical construct. Please remember to use the word of the week when you have the opportunity.

Week 10 - word of the week - Clone

The word of the week this week is clone. The way that this word is used in relation to computers is an example of the english language in the process of change. Webster's third international unabridged dictionary defines clone as a noun, and describes it as a bilogical entity produced by asexual means. You may have heard about bilogical cloning, in which a number of identicle organisisms have been produced from a single organism.

The way that this word is used in a computer context is not in the dictionary right now, but will probably be added if this new usage of the word continues to gain popular acceptance. In a computer context, a clone is an exact or nearly exact copy of something. It may be a picture, or a piece of text that is copied. In addition, in a computer context, the word is also used as a verb (which may be seen as improper some people). Cloning is the act of making an exact copy.

To use clone in a sentence, you might say, "I made this picture of a forest by first drawing a tree, and then just cloning it," or you might say "rather than starting my paper from scratch, I just cloned a paper that I had written for another class," or you could say, "it's great how easy it is to clone a picture in McPaint or HyperCard."

So the word of the week is clone. Remember to use it when you have the opportunity.

Week 11 - word of the week - Digital

The word of the week this week is digital. Virtually all computers today are digital devices.

When computers were first concieved, there were two approaches that were used, digital, and analog. The analogy of a clock is helpful in distinguishing between a digital and an analog device. A clock with hands is an analog device, and we all know what a digitial watch or clock is like. With an analog device, information is represented continuously. The second hand sweeps through time. A digital device represents information as discreet elements. With a digital clock time jumps one minute at a time, not showing partial minutes. The time is represented directly by the discreet numbers on the display.

With a computer, data is handled in a similar way. Going back to a previous word of the week, data in a computer is represented as discreet bits. There is never any question as to what the data is. Each bit is either there, or it isn't. Handling digital data can be more time consuming, and it may require more space than analog data, but these concerns are less important in the computer field than correctness. Since computers generally have relatively large amounts of RAM and are very fast, the primary concern becomes correctness.

To use the word digital in a sentence you could say, "virtually all computers today are digital devices," or you could say "the Mac the Apple II and the IBM PC are all examples of digital computers," or "digital computers are more failsafe than analog computers."

The word of the week this week is digital. Remember to use it when you have the opportunity.

APPENDIX D.

STUDENT PARTICIPATION SURVEYS

Treatment Group A Questionaire

Last 4 digits of 20 ________

For the following questions, please circle the appropriate response. Please answer accurately. It is more important that your answers be accurate, than the answers themselves. This experiment will not effect you grade in this course in any way.

1. I followed the relaxation directions during the class relaxation exercises.

   YES NO

2. After the relaxation exercises, I felt:

   a. No more relaxed than before

   b. A little more relaxed than before

   c. Moderately more relaxed than before

   d. Much more relaxed than before

3. I think relaxation exercises might be something that could be used beneficially in classroom situations.

   YES NO

4. If you have any comments on the processes that you were involved in, please feel free to make them below.

Treatment Group B Questionaire

Last 4 digits of ssn ________

For the following questions, please circle the appropriate response. Please answer accurately. It is more important that your answers be accurate, than the answers themselves. This experiment will not effect you grade in this course in any way.

1. I paid attention to the "word of the week" tape that was played before lab.

   YES NO

2. After listening to the tapes, I believe I:

   a. Learned nothing

   b. Learned a little more than without them

   c. Learned moderately more than without them

   d. Learned a lot more than without them

3. I think short taped lessons of this sort are something that could be very useful in the classroom.

   YES NO

4. If you have any comments on the processes that you were involved in, please feel free to make them below.