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# Computer Anxiety and Attitudes of Urban Teacher Education Students

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COMPUTER ANXIETY AND ATTITUDES

OF URBAN TEACHER EDUCATION STUDENTS

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ABSTRACT

COMPUTER ANXIETY AND ATTITUDES
OF URBAN TEACHER EDUCATION STUDENTS.

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This three-part study used quasi-experimental methodologies to: (a) determine how a computer literacy course affects the computer anxiety and computer attitudes of urban teacher education students over time, (b) explain and predict urban teacher education students who are resistant to reduction of computer anxiety, and (c) determine whether a humanistically-focused treatment is more effective than a traditional cognitively-focused treatment in reducing computer anxiety and improving computer attitudes.

For the first part of this study 75 subjects were measured over three observations using a 13-week interval. The treatment, a mandatory computer literacy course for teacher education students, was conducted between the first two observations. A significant reduction in computer anxiety means and a significant increase in computer confidence means were found across all three observations. Differences in computer liking and computer usefulness means were not significant. Orthogonal polynomial contrasts revealed that the relationship between computer anxiety and the three

observations was 94.75% linear and only 5.25% quadratic, and the relationship between computer confidence and the three observations was strongly linear with a nonsignificant quadratic trend.

A multiple regression analysis was conducted for the second part of this study using 86 subjects. The results of this analysis revealed that 69% of the variance in posttest computer anxiety could be explained by the combined influence of computer confidence, computer knowledge, and trait anxiety. The addition of computer experience, computer liking, computer usefulness, and locus of control to explain the variance in posttest computer anxiety was nonsignificant.

For the final part of this study, 29 subjects were exposed to a cognitively-focused computer literacy treatment and 28 subjects were exposed to a humanistically-focused treatment with each treatment consisting of two groups that were taught by different instructors. After statistically equating groups on the pretest measurement of the applicable dependent variable, a significant increase in computer usefulness means was found in the humanistically-focused treatment group. No significant differences between treatments were found for computer anxiety, computer confidence, and computer liking, and no differences were found between instructors.

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> And certainly there were many others . . . from whom I had assimilated a word, a glance, but of whom as individual beings I remembered nothing; a book is a great cemetery in which, for the most part, the names upon the tombs are effaced (Proust, 1927/1960, p. 256).

The number of people who assisted and encouraged me grew tremendously since I sat in front of my personal computer on November 29, 1994 and created a new word processing document that was to evolve into this dissertation. Unlike my computer, which can remember such details as my spending 6,937 minutes writing and editing this dissertation, I cannot recall everyone who helped me. Consequently I will only acknowledge the few on whom I depended the most: the members of my Dissertation Committee who guided me; the professors at Old Dominion University who teach ECI 304, Educational Applications of Technology, and generously allowed me to use their computer literacy courses for this study; Melody Wilt and Wanda Kaplan who were conscientious independent observers during the spring 1996 semester; and the students who volunteered to assist me and who gave of their time to complete the study questionnaires.

To Dr. Robert Lucking, my Dissertation Chair and friend, I owe a special debt. He was my severest critic, spending

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# CHAPTER I

# INTRODUCTION

## Background

Maintaining and improving the quality of the American public school system is critical to our nation's social and economic well-being, and the effective use of educational technology is a prerequisite for that success (U.S. Congress, 1995). The following reasons are most frequently cited to support the use of computer technology in schools: (a) the improvement of teaching and learning, (b) the preparation of students for living and working in a society of high technology, and (c) the development of a more productive work force. According to a national report from the International Association for the Evaluation of Educational Achievement (Anderson, 1993), 99% of the elementary and secondary schools in the United States have computers, and 85% of the students use them during the school year. In 1995 there were approximately 5.8 million computers in American schools for instructional use, about one computer for every nine students (U.S. Congress, 1995). This emphasis on computer technology is fueled by studies which provide evidence that use of computers by schools is cost-effective and can result in significant increases in achievement and opportunities to learn (Bialo & Silvin, 1991; Kulik & Kulik, 1987, 1991; Ryan, 1991).

Implementation of computer technology in urban schools, with their concentrations of minorities and the poor, is of particular interest. Research shows that Native American, Hispanic, and African-American students and those from lower socioeconomic groups score lower in tests of practical computer knowledge in both the 8th and 11th grades (Anderson, 1993). Therefore, classroom use of computer technology in an urban environment is especially important in order to help prepare at-risk students for a productive future in a technological society.

Computer technology is not self-implementing and does not replace the teacher (U.S. Congress, 1988). Consequently school districts expect teachers, especially new teachers, to be computer literate in order to effectively use this technology (Novak & Berger, 1991). Holzinger (1992) described a computer literate individual as one who naturally turns to the computer as a tool of choice. If teachers do not become computer literate, they are unlikely to take full advantage of computers in the classroom and the potential benefits of computer technology for education will not be achieved. Rohner and Simonson (1981) provided evidence supporting this view. They describe several studies that revealed significant resistance to use of computer technology among teachers in the classroom, despite readily available computer hardware and software.

More recently, the Office of Technology Assessment (U.S. Congress, 1995) reported that despite the availability of technologies in schools, a substantial number of teachers report little or no use of computers for instruction. If "computer-using" teachers are liberally defined as those who require most or all students to do some work on computers during the course of the academic year without regard to frequency of use, then about one-half of 5th-grade teachers, one-third of 8th-grade English teachers, and one-fifth of 11th-grade English teachers qualified. The Office of Technology Assessment also reported that average student academic use of computers were: (a) 24 minutes per week in grade 5, (b) 38 minutes per week in grade 8, and (c) 61 minutes per week in grade 11. Clearly, these findings provide evidence that the millions of computers in American public schools are not used to full advantage.

Anderson (1983) observed that many people are "intimidated (by computers), whether or not they openly admit it. Intimidation, with its long time partner, fear, are extremely effective blockers of learning" (p. 114). This psychological reaction to computers is a manifestation of computer anxiety.

Howard (1986) has developed a theory of computer anxiety that is useful to help explain why some teachers resist using computers in the classroom. He theorized that many

individuals experience stress in anticipation of using a computer (i.e., they experience computer anxiety). They respond to this stress based upon their computer experience, knowledge about computers, and psychological makeup. These responses can be classified according to intensity and permanence. For some individuals, the intensity of this reaction is great enough and the duration is long enough to create a significant barrier to computer use.

Research provides ample evidence that computer anxiety affects many teachers. Becker (1991) found that teachers demonstrate varying behaviors regarding computers, ranging from overt resistance to aggressive embracement. DeLoughry (1993) reported the results of a three-year study involving 1,600 university students in which 40% of the subjects manifested significant levels of computer anxiety.

Evans-Andris (1995) conducted an ethnographic study of nine urban elementary schools in order to identify the strategies teachers adopt in order to interact with computers. She identified three computing strategies among elementary teachers: avoidance, integration, and specialization. Over 60% of teachers in her study adopted avoidance strategies. She described teachers using this strategy as evading meaningful interaction with computers whenever possible. These teachers provided no or minimal computer experiences for their students. In contrast, nearly

30% of the teachers embraced computer technology and fully integrated it in their teaching. These teachers used computers in creative ways that enhanced learning. Finally, nearly 10% of the teachers engaged in technical specialization. Evans-Andris asserts that these teachers focused on promoting the technical aspects of computers, but generally failed to use computers in ways that were relevant to students. Although she did not report data regarding the computer anxiety and computer attitudes of her subjects, it is clear that the majority of the teachers in her study avoided computers when given a choice.

The results of such research provide evidence that support Howard's (1986) view that the movement of society toward increased computerization will lead to even higher rates of computer avoidance. Howard believes such avoidance is likely due to computer anxiety.

However, there are no assurances that teachers with low computer anxiety will embrace computer technology. Research evidence suggests that teachers must also have requisite knowledge and skills, and possess positive attitudes about computers before they will internalize this technology (Hunt & Bohlin, 1991; Loyd & Gressard, 1984; Savenye, Davidson, & Orr, 1992).

Loyd and Gressard (1984) identified three types of computer attitudes that are relevant to computer use:

computer confidence, computer liking, and computer usefulness. More recently, the attitude of computer confidence, or computer self-efficacy, has received increased attention in the literature reflecting its importance (Schunk, 1989). To summarize, research suggests that teachers who use computers effectively in the classroom are likely to have little or no computer anxiety and possess requisite knowledge, skills, and positive attitudes about computers, particularly self-confidence in their abilities to use this technology.

Papert (1988) believes society is becoming a computer culture in which schools are being left behind because educators failed to reconceptualize the uses of the computer and to train teachers accordingly. In support of this view the Office of Technology Assessment (U.S. Congress, 1988) identified teacher training as one the most critical factors in the successful implementation of technology.

There are approximately 1,300 institutions of higher education in this country that prepare future public school teachers (U.S. Congress, 1995). In the next decade, American schools will need to hire about two million teachers. Ideally these new teachers should be able to use computers effectively and help their students become computer literate. The most direct and cost-effective way to educate teachers about technology and to make them comfortable using computers

is through the preservice education they receive in teacher education programs at institutions of higher learning (U.S. Congress, 1995).

Therefore, research in computer anxiety and attitudes about computers in a teacher education program at an urban university is important, timely, and worthwhile. If universities are to confront the problems of computer anxiety and negative attitudes about computers, then research must identify the individuals that are most susceptible to computer anxiety and the type of course that is most effective in reducing computer anxiety and improving attitudes about computers. Helping new teachers reduce computer anxiety and improve their attitudes about computers may be one of the most important steps to assuring that current and future investments in educational technology are realized.

## Problem Statement

Despite interest in the literature about computer anxiety and attitudes about computers, research on treatments has been underproductive, partly because an optimum treatment has not been identified. There remains a continuing need for research to examine the relative effectiveness of various treatment approaches to reducing computer anxiety and improving computer attitudes in teacher education students.

Research has focused on cognitive learning approaches despite theoretical evidence that links computer anxiety with the need to change basic attitudes (Howard, 1986). Such a link suggests the necessity to use affective learning outcomes to address the need to change attitudes about computers.

Additionally, research provides evidence that a computer literacy course can reduce computer anxiety and improve computer attitudes (i.e., computer confidence, computer usefulness, and computer liking) (Delcourt & Kinzie, 1993). However, no published research exists that examines either the durability of such a treatment beyond treatment termination or individuals who are resistant to reduction of computer anxiety. This study examines outcome variables prior to treatment, at the conclusion of treatment 13 weeks later (immediate treatment effects), and 13 weeks after the conclusion of treatment (delayed treatment effects). An inspection of delayed treatment effects should provide evidence regarding whether or not the gains, if any, that were made between the pretest and posttest observations were maintained in the absence of an ongoing treatment.

Accordingly, this study addressed the following problems:

1. How does a computer literacy course affect computer anxiety and attitudes about computers in teacher education students over time?

2. How can teacher education students who are resistant to reduction of computer anxiety be explained and reliably predicted?

3. What is the best type of treatment for reducing computer anxiety and improving computer attitudes in teacher education students?

## Purpose and Rationale

### Purpose

The purpose of this study was to: (a) determine how a computer literacy course affects the computer anxiety and computer attitudes of urban teacher education students over time; (b) explain and predict urban teacher education students who are resistant to reduction of computer anxiety; and (c) determine whether a humanistically-focused treatment, that incorporates both cognitive and affective learning outcomes, is more effective than a cognitively-focused treatment in reducing computer anxiety and improving computer attitudes.

### Rationale

Research provides evidence that both computer anxiety and attitudes about computers are related to computer avoidance by teachers (Delcourt & Kinzie, 1993). Accordingly,

this study employed the triangulation of measurement process by using two classes of outcome measurements: computer anxiety and attitudes about computers. Furthermore, multiple outcome variables were used to measure attitudes about computers: computer confidence, computer usefulness, and computer liking. Using the triangulation of measurement process and multiple outcome variables reduce the risks associated with conducting research and making recommendations based on a single criterion that may not be as representative of the systemic output of an educational process.

The longitudinal design used in this study to analyze computer anxiety and computer attitudes over time provides three observations of the outcome variables, including a delayed test observation 13 weeks after the end of the treatment. If the effects of the treatment are durable, then the variable measurements taken at the delayed test observation should remain roughly equal to the measurements taken at the completion of the intervention. That is, these measurements should reveal little regression toward the pretest levels of computer anxiety and attitudes about computers. The effects of different teachers is also of interest in order to determine if similar treatments taught by different teachers result in significantly different outcomes.

Howard (1986) theorized that the sources or roots of computer anxiety are: (a) lack of operational experience, (b) inadequate knowledge about computers, and (c) psychological makeup. He asserted that lack of operational experience with computers is the easiest to treat, inadequate knowledge about computers is more difficult to treat, and psychological makeup is the most difficult to treat. If Howard is correct, the best predictors of computer anxiety at the end of a computer literacy course are related to an individual's psychological makeup because Howard asserts they are the most difficult to treat. He identified trait anxiety (i.e., generally anxious individuals), locus of control, and attitudes about computers as potentially important variables in this regard. Loyd and Gressard (1984) identified computer confidence, computer liking, and computer usefulness as important computer attitudes. Therefore, this study treats computer confidence, computer liking, computer usefulness, locus of control, and trait anxiety as potentially important variables that are related to an individual's psychological makeup and thus may be useful in predicting computer anxiety at the end of a computer literacy course.

If subjects resistant to computer anxiety reduction require changes in attitudes about computer technology (Howard, 1986), then a humanistically-focused treatment that includes affective as well as cognitive learning outcomes may

be more effective in reducing computer anxiety than the more traditional cognitively-focused treatment. The rationale is that affective learning outcomes focus on changing attitudes and values. Evidence to support this approach can be found in the work of Themes (1982) who showed that the rational-emotive treatment developed by Ellis and Abrahams (1978), which emphasizes affective educational objectives to help individuals change their negative beliefs about math, was a successful treatment for math anxiety in women with trait anxiety. Although Themes studied math anxiety, research provides evidence that math anxiety is related to computer anxiety (Oetting, 1983; Raub, 1981) and to trait anxiety (Themes, 1982). Therefore, an approach which was successful in treating math anxiety in generally anxious individuals may also be an effective treatment for computer anxiety.

Additionally, the effects of different teachers is of interest in order to determine if cognitively-focused and humanistically-focused treatments taught by different teachers result in significantly different outcomes. The results of such analysis should provide evidence regarding the sensitivity of treatment efficacy to different teachers.

## Significance of the Study

Computer anxiety is an urgent problem because of the importance of computer technology to our industrialized nation. Computer anxiety and negative attitudes about

computers may, in fact, cut off individuals from full participation in our society.

This study contributes to the understanding of computer anxiety and attitudes about computers as it applies to an urban teacher education student population and provides information concerning educational practices that reduce computer anxiety and improve attitudes about computers. Developing treatments that are instrumental in helping teacher education students attain a level of computer literacy that, according to Holzinger (1992), enables them to turn to the computer as a problem solving tool of choice, is important. Producing new teachers with less computer anxiety and positive attitudes about computers may benefit school systems by providing them with a source of new teachers who are better able to utilize computer technology in the classroom.

## Research Questions

This study pursued answers to the following questions using quasi-experimental methodologies:

1. What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?
2. Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the

end of a computer literacy course and what optimum weight should be associated with each predictor?

3. How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and course instructor?

<u>Assumptions</u>

The following assumptions were made for the purpose of this study:

1. The conduct of the study did not have a reactive effect on the subjects' measured anxiety and attitudes.

2. Subjects responded honestly to the questions on the self-report questionnaires.

3. Sufficient stimuli were present for extant computer anxiety to manifest itself during all measurements of computer anxiety.

4. Study results can be generalized to the experimentally accessible population and to the target population.

<u>Delimitations and Limitations</u>

The following boundaries and qualifications apply to this study:

1. The study confines itself to an examination of teacher education students at an urban state university.

2. There was no random selection or random assignment of subjects. The subject pool consisted of intact groups of students enrolled in ECI 304, Educational Applications of

Technology, during the 1995-96 academic year at Old Dominion University.

3. Attribution of causality cannot be inferred from study results because true experimental designs with random assignment of subjects were not used.

4. All subjects were volunteers from the subject pool. In the case of research questions number 1 and number 2, subjects were paid volunteers.

5. Only self-report instruments were used to measure computer anxiety and attitudes about computers. There were no measurements of treatment effects across multiple response domains. For example, there was no attempt to measure computer anxiety based on behavioral or physiological indicators (i.e., respiration rate, heart rate, blood pressure, and galvanic skin response).

## Definition of Terms

The following definitions were used in this study.

Affective is "the feeling or emotional aspect of experience and learning. How a child or adult feels about wanting to learn, how he feels as he learns, and what he feels after he has learned" (Brown, 1971, p. 4).

Anxiety is a psychological construct whose definition defies consensus. A common view is that anxiety is "the apprehension cued off by a threat to some value that the

individual holds essential to his existence as a personality" (May, 1977, p. 205).

Application is a teaching method that provides learners the opportunities to apply learned material, e.g., using a computer. It includes individual and group projects, case studies (including discussion), and simulations (e.g., role playing and games) (Kozma, Belle, & Williams, 1978).

Attitudes are "learned predispositions to respond positively or negatively to certain objects, situations, concepts, or persons" (Aiken, 1980, p. 2).

Cognitive learning pertains to "the activity of the mind in knowing an object, of intellectual functioning. What an individual learns and the intellectual process of learning it would fall within the cognitive domain – unless what is learned is an attitude or value, which would be affective learning" (Brown, 1971, p. 4).

Cognitively-focused treatment, as used in this study, is a course of instruction that contains stated learning outcomes exclusively from the cognitive domain as defined by Bloom, Englehart, Furst, Hill, and Krathwohl (1956).

Computer anxiety is "the irrational fear or apprehension felt by an individual when using computers or when considering the possibility of computer utilization" (Mauer & Simonson, 1984, p. 2). Also referred to by the terms "computerphobia" or "cyberphobia" by some authors.

Computer assisted instruction (CAI) refers to the "use of the computer to assist in instructional activities. Commonly used to refer to tutor applications, such as drill-and-practice programs, tutorials, simulations, and games" (Merrill, Hammons, Tolman, Christensen, Vincent, & Reynolds, 1992, p. 320). CAI is also referred to as instructional technology.

Computer managed instruction (CMI) refers to "the use of the computer to manage the instructional process, including maintenance of student records, controlling the availability and timing of instructional events, and providing progress reports to instructors, students, parents, and administrators" (Merrill et al., 1992, p. 321). CMI is also referred to as productivity tools.

External locus of control is "the belief that reinforcements are in the hands of other people, of fate, or of luck and that one is powerless with respect to these outside forces" (Schultz, 1990, p. 484).

Humanistic learning is "the integration or flowing together of the affective and cognitive elements in individual and group learning" (Brown, 1971, p. 3). Also referred to by the term "confluent education" by some authors.

Humanistically-focused treatment, for the purpose of this study, is a course of instruction that contains stated

learning outcomes from both the cognitive (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and affective domains (Krathwohl, Bloom, & Masia, 1964).

Internal locus of control is "the belief that one's reinforcements are brought about by one's own behavior and attitudes" (Schultz, 1990, p. 484).

Locus of control is "an individual's belief about the source of control of the reinforcements he or she receives" (Schultz, 1990, p. 484).

Presentation is a teaching method that includes lecture (formal or informal presentation of information, concepts, or principles by a single individual, with or without questioning), demonstration-performance (presentation or portrayal of a sequence of events to show a procedure), reading (books, periodicals, handouts, etc.), and self-paced or programmed instruction (Kozma, Belle, & Williams, 1978).

Self-efficacy is "the conviction that one can successfully execute the behavior required to produce the outcomes" (Bandura, 1977, p. 79).

State anxiety is the "subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system" (Spielberger, 1966, p. 16-17).

Trait anxiety is "a motive or acquired behavioral disposition that predisposes an individual to perceive a wide

range of objectively nondangerous circumstances as threatening, and to respond to these with anxiety state reactions disproportionate in intensity to the magnitude of the objective danger" (Spielberger, 1966, p. 17).

Verbal interaction is a teaching method that includes questioning and discussion including guided discussion (teacher-facilitated interactive process of sharing information, experiences, and feelings) and nondirected discussion (such as peer-controlled group discussion) (Kozma, Belle, & Williams, 1978).

## Conclusion

Chapter I provided an introductory background and general statement of the problem regarding computer anxiety and unfavorable computer attitudes of urban teacher education students in order to furnish the reader with an appreciation of the problem's practical and theoretical significance and to provide a rationale for the research described in this dissertation. The remaining chapters address the problem in greater depth.

# CHAPTER II

# LITERATURE REVIEW

## Introduction

The purpose of this chapter is to review the literature in order to: (a) provide a background and theoretical framework for this study, and (b) summarize relevant research. The review focuses on literature concerned with computers, general anxiety, computer anxiety, and attitudes about computers. The section on computer anxiety research identifies correlates to computer anxiety in order to provide insights into potential variables that can predict individuals who are resistant to reduction of computer anxiety. Humanistic learning is also reviewed as a potential treatment approach to reduce computer anxiety and improve attitudes about computers.

## Computers

Computers have been around in one form or another for centuries. However, they have made their greatest impact on society in this century.

Blaise Pascal is generally credited with building the first "digital calculating machine" in 1642 that performed addition. He was followed by Gottfried Wilhelm von Leibniz who invented a calculator in 1671 that could add and multiply. However, the public generally viewed these machines as curiosities. Charles Xavier Thomas developed the first

commercially successful mechanical calculator in 1820 that could add, subtract, multiply, and divide. There followed a succession of improved mechanical calculators by various inventors.

A step toward automated computation was the introduction of punched cards in 1890. The first generation of modern programmed electronic computers appeared in 1947. New discoveries during the 1950s transformed the image of the computer from one of fast but often unreliable hardware to one of relatively high reliability and greater capability. This trend continued into the 1970s when the focus shifted away from powerful, centralized computers to a broader range of computers to include compact, less costly systems.

Small, powerful, and low cost computers for the home, called microcomputers, were made possible by progress in microelectronics. Microcomputers were initially used for home entertainment, record keeping, and word processing. The development of more powerful microprocessors and advances in networking in the mid- to late 1980s enhanced the power of microcomputers to such an extent that they are now widely used in government, businesses, schools, and homes in a broad range of applications. Zefran (1984) writes that "the revolutionary aspect of the small computer is that the power of the computer is now available to be used in new ways and for a wider group of people" (p. 19).

Numerous studies have been conducted to determine the effects of computer use on student learning and instructional time. These studies provide evidence that school use of computers can have positive results. In their meta-analysis of 199 studies, Kulik and Kulik (1987) found that CAI, when compared to traditional instruction: (a) increases test scores by .31 standard deviation, (b) reduces instructional time by an average of 32%, and (c) increases retention.

In another meta-analysis of 40 studies, Ryan (1991) reported that training of teachers in CAI can result in increased student academic achievement. She found that teachers who received more than 10 hours of computer training achieved up to 72% additional gain in student achievement scores over the average computer using class.

## Anxiety

Anxiety has existed for millennia. It is a state of being that most people have experienced to varying degrees. Epictetus, a first century Roman philosopher, recognized this construct when he wrote, "Man is disturbed not by things, but by his opinion of things" (Benson, 1984, p. 4).

The 20th century has been called the "age of anxiety" because of the heightened incidence of anxiety (Spielberger, 1979). May (1977) hypothesized that this phenomena may be related to rapid and unpredictable cultural changes, such as the massive introduction of technology into our society.

According to Cambre and Cook (1984), the concept of anxiety still defies theoretical and methodological consensus. They pointed out that "if the study of anxiety is characterized by any one thing it is the lack of uniformity regarding its definition, cause(s), and measurement" (p. 5). Despite this lack of uniformity, one definition for anxiety that is found in the literature is the "apprehension cued off by a threat to some value that the individual holds essential to his existence as a personality" (May, 1977, p. 205). The concept of anxiety, as used in this dissertation, makes use of May's definition.

The state-trait anxiety model developed by Spielberger (Gaudry & Spielberger, 1971) is a theoretical framework for a unidimensional person-by-situation interaction approach to anxiety that is primarily ego threatening. This model includes two anxiety types developed in factor analysis studies by Cattell and Scheier (1961): (a) trait anxiety, which is a general proneness to be anxious and is psychologically related; and (b) state anxiety, which is a reaction to a specific stimulus at a particular point in time.

Spielberger (1983) wrote "anxiety states are characterized by subjective feeling of tension, apprehension, nervousness, and worry, and by activation or arousal of the autonomic nervous system" (p. 4). State anxiety can be

inferred from: (a) behavioral performances, (b) physiological measures such as galvanic skin response, and (c) self-rating scales (Gaudry & Spielberger, 1971).

Trait anxiety has the characteristics that Campbell (1963) referred to as "acquired behavioral positions." These positions involve elements of past experience that dispose an individual to view the world in a certain way and to manifest "object-consistent" response tendencies. According to Spielberger (1983):

> Trait anxiety may also reflect individual differences in the frequency and intensity with which anxiety states have been manifested in the past, and in the probability that state anxiety will be experienced in the future. The stronger the anxiety trait, the more probable that the individual will experience more intense elevations in state anxiety in a threatening situation. (p. 5)

Because high trait anxiety people are concerned with "fear of failure," according to Spielberger (1983), they are more likely to perceive situations that involve the ego as more threatening than would low trait anxiety persons. Furthermore, they should exhibit more intense levels of state anxiety arousal in ego-threatening situations than low trait anxiety persons. In nonthreatening situations, the level of state anxiety arousal should be about the same for both high and low trait anxiety people.

The main assumptions of the state-trait anxiety model (Gaudry & Spielberger, 1971) are summarized as follows:

1. For all situations that are appraised by an individual as threatening, a state anxiety reaction will be evoked;

2. Individuals with high trait anxiety will perceive situations or circumstances that involve failure or threats to self-esteem as more threatening than will persons who are low in trait anxiety;

3. The intensity of the state anxiety reaction will be proportional to the amount of threat that the situation poses for the individual;

4. The duration of the state anxiety reaction will depend upon the persistence of the individual's interpretation of the situation as threatening;

5. High levels of state anxiety will be experienced as unpleasant through sensory and cognitive feedback mechanisms;

6. Elevation in state anxiety has drive properties which may be expressed directly in behavior, or which may serve to initiate psychological defenses that have been effective in reducing state anxieties in the past;

7. Stressful situations that are encountered frequently may cause an individual to develop coping responses or

psychological defense mechanisms which reduce state anxiety by minimizing the threat. (p. 69)

## Computer Anxiety

### Theoretical Framework

Howard (1986) used the state-trait anxiety model to conceptualize a multidimensional model for computer anxiety involving: (a) intensity (i.e., high, medium, and low computer anxiety), and (b) permanence (i.e., trait anxiety, which tends to be long lasting, and state anxiety, which tends to be of short duration). The stimulus (i.e., a computer) produces a threat to the afflicted individual's ego or self-concept. Using computers is viewed as a situation that can make an individual appear dull-witted and, therefore, becomes a threat to the individual's self-image as a bright and competent person.

Howard classified the sources of computer anxiety as: (a) lack of operational experience, (b) inadequate knowledge about computers, and (c) psychological makeup. Although related, knowledge and experience are not synonymous. For example, a computer operator who repeatedly performs a limited number of computer tasks on a daily basis may have substantial computer experience but relatively little computer knowledge.

Computer anxiety that is based solely on a deficiency of operational experience with computers is state anxiety. The

reactions of afflicted subjects fluctuate according to the presence or absence of a computer. This form of anxiety can be treated by providing experience to reduce operational concerns.

At the other extreme, computer anxiety that is based solely on psychological sources is trait anxiety. According to Howard's model, subjects who are resistant to reduction of computer anxiety have trait anxiety and require treatment that results in basic changes in their attitudes about computer technology.

Between these two extremes, computer anxiety can take on various characteristics of state anxiety and trait anxiety depending on the subject's makeup. Consequently the origin of the response should affect the type of treatment. For example, if the origin of the response is 50% based on operational roots, 40% based on knowledge roots, and 10% based on psychological roots, presenting the individual with computer experience and knowledge addresses 90% of the problem. The 10% of the problem stemming from psychological roots goes untreated.

Based on his literature review of correlates to computer anxiety, Maurer (1994) developed and published a computer anxiety model that is similar to Howard's model. Maurer believes that computer experience is the variable that interacts most directly with computer anxiety. Additionally,

personality characteristics, such as locus of control, can directly influence the development of computer anxiety. He asserts that other variables, such as demographic characteristics (e.g., socioeconomic status or sex) and life choices (e.g., academic major or career choices), can interact indirectly with computer anxiety by affecting the amount of computer experience. He believes the relationships between these variables are complex and asserts cycles may exist between variables (e.g., computer experience influences life choices which, in turn, affects computer experience, which ultimately affects computer anxiety).

Research into Computer Anxiety

Introduction. A substantial amount of research exists in the area of computer anxiety. Much of this research concerns the relationship of computer anxiety to other variables. The major research goals have been to identify correlates to computer anxiety and to determine the relationship between computer anxiety and various treatments, primarily computer literacy courses, that may reduce computer anxiety in some subjects.

Rosen and Maguire (1990) described a computer anxiety meta-analysis that examines published research reports from the early 1960s through 1989. Their meta-analysis provides substantial evidence that: (a) computer anxiety exists, (b) women are not necessarily more computer anxious than men, (c)

older people are not necessarily more computer anxious than younger people, (d) computer anxiety is not simply an extension or manifestation of math anxiety, (e) computer anxious people are not simply anxious people manifesting their anxiety in a specific area, and (f) computer experience alone does not cure computer anxiety.

Rosen, Sears, and Weil (1993) conducted the only study that could be found in the literature that provides a longitudinal evaluation of a computer anxiety reduction program. This program consisted of a psychologically-oriented individualized intervention strategy that was available to all students across a university campus who were enrolled in classes with computer interaction. Program components were: (a) an individualized assessment of computer anxiety, (b) a graduate student internship program, (c) personalized treatment programs, and (d) an outreach component. The program was five hours in length and spanned a five week period at the beginning of each semester. The results demonstrate significant decrease in computer anxiety and improved attitudes about computers at the end of the treatment. Furthermore, six months later subjects showed a maintenance of program gains plus a significant increase in computer use.

In contrast to the study conducted by Rosen, Sears, and Weil (1993), this study examines computer anxiety in the

context of a computer literacy course within an urban university teacher education program. Consequently, examinations of possible correlates to computer anxiety and treatments to reduce computer anxiety are particularly relevant to this study.

Academic major. Research does not provide evidence that academic major is a strong predictor of computer anxiety, although some evidence suggests that education majors may be at risk. Previous research findings in this area are mixed. Rohner and Simonson (1981) reported no significant relationship between academic major and computer anxiety. Various other researchers reported some relationship: (a) Liu, Reed, and Phillips (1990) concluded that university students majoring in English education, elementary education, special education, social studies education, and physical education were consistently more computer anxious than math and science education majors; (b) Griswold (1985) found that education majors had significantly higher anxiety than business majors; and (c) Brooke (1989) reported that computer science majors were considerably less anxious than other students in one sample, and business administration majors were less anxious than arts, sciences, and education majors in another sample.

Achievement. The results of published studies that examine the relationship between academic achievement and

computer anxiety are also mixed. Two studies reported no relationship between academic achievement and computer anxiety (Kernan & Howard, 1990; Munger & Loyd, 1989) and another two studies reported an inverse relationship between academic achievement and computer anxiety (Hayek & Stephens, 1989; Marcoulides, 1988).

Computer experience. Many studies provided evidence that computer experience is related to low computer anxiety (Gordon, 1993; Howard, 1986; Hunt & Bohlin, 1991; Liu, Reed, & Phillips, 1990; McInerney, McInerney, & Sinclair, 1990; Okebukola, Sumampouw, & Jegede, 1992). However, no studies established a cause and effect relationship. For example, lower computer anxiety could be a cause of greater computer experience and computer ownership, and not the reverse.

Several studies manipulated experience by examining computer anxiety before and after a computer course. Research evidence points to an inverse relationship between computer anxiety and completion of a computer course (Torris, 1985). However, a deficiency found in many of these studies is that the course was not sufficiently defined, making it very difficult to generalize the effects of computer courses on computer anxiety or to identify the specific experiences that may be related to the reduction of computer anxiety. Additionally, no evidence exists regarding how long

reductions in computer anxiety can be maintained following an intervention consisting of a computer literacy course.

Savenye, Davidson, and Orr (1992) reported on a study to investigate the effects of participation in an undergraduate computer literacy course designed to teach teacher education students how to use computers and how to successfully integrate computers in their own classrooms. They concluded that such a course can reduce computer anxiety and enhance student attitudes about computers. However, they recommended that further research should be conducted to study the relationships between computer attitudes and anxiety with other student characteristics.

Overbaugh (1993) found that computer anxiety can be significantly reduced by an intervention as short as six hours. Results of four studies involving teacher education students showed: (a) a cognitively demanding six hour one day hands-on session is sufficient to significantly reduce computer anxiety, (b) it makes no difference whether the delivery of the intervention is via a one-day format (a single six-hour session) or a three-day format (three two-hour sessions spread over three weeks), and (c) a less cognitively demanding experience can also significantly reduce computer anxiety (Overbaugh & Reed, 1990; Overbaugh, 1993).

In contrast, Honeyman and White (1987) suggested that longer courses of instruction are more effective than shorter courses in reducing computer anxiety. To support their view, they describe a study involving a semester-long computer literacy course during which significant reduction of computer anxiety occurred only during the second half of the course.

A possible explanation for the inconsistency between the work of Overbaugh and Honeyman and White is that either course content or teacher, which was not the same in both studies, affected research results.

Leso and Peck (1992) described a study that sought to examine computer anxiety differences in undergraduate university students voluntarily entering two different types of computer courses: (a) an introductory computer literacy course that emphasized tools software applications, and (b) an introductory problem-solving and programming course. Results indicated that initial computer anxiety levels were not significantly different. However, reduction of computer anxiety was significantly greater for students in the computer literacy course than for students in the problem-solving and programming course. Results also showed that one-third of the subjects in the computer literacy course and two-thirds of the subjects in the problem-solving and programming course exhibited no reduction in anxiety after

completing their respective courses. This research provided evidence that: (a) there is a relationship between computer course content and reduction of computer anxiety, and (b) relatively large numbers of individuals appear to be resistant to reduction of computer anxiety. The authors recommended additional research to investigate: (a) the ability of different treatments to reduce computer anxiety, and (b) differences between subjects exhibiting reductions in computer anxiety and those for whom treatments had no apparent impact. This study addresses both of these issues.

Weil, Rosen, and Wugalter (1990) found that "experience alone will not eliminate computerphobia and in many instances will exacerbate the existing problem" (p. 362). They believe that the benefits of computer experience depend on how the experience is interpreted or judged by the individual (i.e., a judgment of self-efficacy). A beneficial experience is interpreted by an individual in a positive manner. A bad experience with computers can lead to even greater computer anxiety.

Rosen and Maguire (1990) support this view when they concluded:

> Past experience is inversely related to computerphobia (computer anxiety), but this is hardly surprising when you consider that computerphobics actively avoid computer interaction whenever possible. During "forced"

> computer interaction computerphobics take more time, make more errors and perform more poorly than noncomputerphobics. Rather than "curing" their computerphobia, each additional computer experience strengthens their negative affective reactions and promotes further computer avoidance. (p. 187)

In summary, research evidence suggests an inverse relationship between computer experience (including university computer courses) and computer anxiety, although evidence also suggests that attitudes, duration, and content can be mediating variables that influence outcomes.

Locus of control. Several studies (Coovert & Goldstein, 1980; Griswold, 1985; Howard, Murphy, & Thomas, 1987; Morrow, Prell, & McElroy, 1986) reported a significant relationship between locus of control and computer anxiety. They found that externally-oriented subjects are more likely to state that the computer controlled them rather than the opposite. Internally-oriented subjects had more favorable attitudes about computers. These findings are consistent with the work of Lazarus (1966) who theorized that internalizers are better able to handle psychologically-perceived threats and are less likely to be anxious in an otherwise threatening situation.

Based on this research, locus of control is a potential predictor for retained computer anxiety.

Math anxiety. Although research evidence suggests a relationship between math anxiety and computer anxiety, the relationship does not appear to be strong. A low correlation was found to exist between math anxiety and computer anxiety in several studies (Raub, 1981; Oetting, 1983; Gressard & Loyd, 1987; Marcoulides, 1988). Raub (1981) reported a correlation of .30 between math anxiety and computer anxiety. Oetting (1983) found a correlation of .42 between math anxiety and computer anxiety.

Sex. The results of research on the issue of sex and computer anxiety are complex and mixed, thus precluding the use of sex as a predictor variable in this study. Several studies concluded that females possess higher levels of computer anxiety than males (Cambre & Cook, 1984; Johassen, 1985; Brooke, 1989; Liu, Reed, & Phillips, 1990). Other studies found no significant correlation between sex and computer anxiety (Hunt & Bohlin, 1991; Gordon, 1993).

McInerney, McInerney, and Sinclair (1990) believe that the relationship of sex difference to computer anxiety is complex and unresolved. A possible confounding variable is computer experience. Research provides evidence that prior computer experience is greater with males than females (Levin & Gordon, 1989) and parents tend to provide computers more for male children than for female children (Campbell, 1989).

Rosen, Sears, and Weil (1987) took a different approach at examining the issue of sex and computer anxiety. They examined the relationship between computer anxiety and gender role as measured by the Bem Sex Role Inventory (Bem, 1974). They found that "feminine-identity students had more computer anxiety and more negative computer attitudes than did masculine identity students, regardless of gender" (p. 178).

Conclusions

Research provides evidence that computer experience, computer knowledge, trait anxiety, and locus of control are possible correlates of computer anxiety. Consequently these variables will be used in this study as potential predictors of post-treatment computer anxiety.

## Attitudes

Attitudes are "learned predispositions to respond positively or negatively to certain objects, situations, concepts, or persons" (Aiken, 1980, p. 2). Attitudes contain an affective dimension composed of feelings that influence the acceptance or rejection of the target object. They also contain a cognitive dimension in which the individual has internalized his or her views toward the object through an intellectualization process. For example, one can become quite passionate on the issue of abortion, thus manifesting the affective dimension of one's attitude on this subject. The cognitive dimension is demonstrated by one's ability to

verbalize his or her views on abortion, defend them logically, and state how he or she arrived at them.

Oftentimes cognitive means can be used to achieve affective learning outcomes, since learning about a subject, such as abortion, can produce attitudinal changes in individuals (Ringness, 1975).

## Computer Attitudes

### Theoretical Framework

Computer attitudes represent a specific example within the attitude construct in which the target object is the computer.

In addition to low computer anxiety, the literature provides evidence that teachers must also have positive attitudes about computers before they will embrace this technology (Delcourt & Kinzie, 1993). Anderson, Hansen, Johnson and Klassen (1979) believe attitudes toward new technologies are predictive of their adoption. Consequently, both computer anxiety and negative computer attitudes may adversely affect a teacher's choice to embrace computer technology.

Gressard and Loyd (1985) identified three computer attitudes that appear to be significant. They are: (a) having confidence in one's abilities to use computers, (b) viewing computers as useful, and (c) liking to use computers. Delcourt and Kinzie (1993) believe that these teacher

attitudes are strongly influenced by prior training. Therefore, it may be important to examine treatments in terms of the attitudes they nurture.

The confidence variable, or self-efficacy, may be particularly important (Bandura, 1977; Delcourt & Kinzie, 1993). Self-efficacy is an individual's confidence in his or her ability to perform the behavior required to produce specific outcomes (Bandura, 1977). Positive outcome expectations are important, but they do not guarantee specific behavior (Schunk, 1985, 1989). Although teachers may believe that computers will lead to improved teaching and learning (positive outcome expectations), they may nonetheless choose not to use this technology if they have low confidence in their abilities to use it (low self-efficacy). In other words, without self-efficacy, performance may not occur at all (Mager, 1992).

Schunk (1989) makes an important point regarding the relationship of self-efficacy and behavior:

> We can only infer that learning takes place; we do not observe it directly but rather the behavior presumably brought about by learning. If students successfully perform a new behavior, we safely conclude that they have learned. Conversely, we cannot necessarily infer that students who do not perform a behavior have not

> learned it. They may be unmotivated, anxious, feeling ill, or believe that performance is unimportant. (p. 14)

Bandura (1977) addressed this issue when he hypothesized that perceived self-efficacy can affect choice of activities. In other words, people who hold a low sense of efficacy for accomplishing a task may avoid it, whereas those who believe they are capable may participate more eagerly. Additionally, self-efficacy theory postulates that self-efficacy also influences effort expenditure and task accomplishments (Bandura, 1982).

Bandura (1977) believes the formation of self-efficacy is a dynamic process involving information from four major sources: (a) vicarious experiences (e.g., watching television), (b) persuasive statements, (c) physiological states, and (d) performance accomplishments. Of these four sources, performance accomplishments (e.g., test results and successful task completion) appear to be the most important because: (a) it is based on direct, personal experience, and (b) mastery is often attributed to one's own effort and skill.

Schunk (1985, 1989) points out that self-efficacy is not the only influence on behavior. Requisite knowledge and skills are also important. Additionally, Schunk (1985) believes it is important to address self-efficacy with regard to specific performances rather a global construct. For

example, a teacher may have high self-efficacy in his or her ability to drive an automobile, but low self-efficacy in his or her ability to use a computer.

Translating the preceding theoretical framework to computers, one can theorize several possible prerequisites to computer-literacy in teachers and willingness to use computers in the classroom: (a) acquisition of knowledge and skills about computers, (b) positive attitudes about computers, including feelings of self-efficacy and believing computer technology is important (i.e., it is useful), and (c) low computer anxiety.

Research into Computer Attitudes

Research evidence suggests that computer attitudes are also related to experience with computers (Koohang, 1986, 1989; Gardner, Discenza, & Dukes, 1993). Hunt and Bohlin (1991) found that previous computer experiences correlate highly with positive attitudes towards using computers among students enrolled in educational computing courses for classroom teachers. Recreational use of computers was the strongest predictor.

Hunt and Bohlin (1991), in a study using teacher education students, concluded that student attitudes toward working with computers are important indicators of the ways in which they will use computers as classroom teachers.

Stimmel, Conner, McCaskill and Durrett (1981) studied the attitudes of teachers toward computers, CAI, and the fields of teaching math and science. Subjects were provided a self-report inventory and asked to rate each variable using a Semantic Differential scale. Factor analysis was used on each variable to determine its principle loadings. The results showed strong negative affect for all the variables, especially attitudes toward computers, CAI, math, and teaching math. The authors concluded that more emphasis should be placed on the positive aspects of computers in teacher education programs.

Offir (1983) found that teachers' views toward computer use in the classroom can differ from their willingness to actually use computers in their own classrooms. The goal of Offir's study was to analyze the attitudes of university teachers towards the use of CAI in their classes. The study was limited to teachers teaching a physiology course. Data were gathered by observation, interviews, and questionnaires. An analysis of the data showed positive attitudes towards using computers in the process of teaching physiology. Subsequently, computer software was developed for the physiology course according to teacher comments. Each teacher was also given the opportunity to modify the software to better suit course learning outcomes. Although all teachers expressed positive attitudes concerning CAI, none of the

teachers chose to use the software. Although Offir did not speculate as to the cause of this discrepancy, he hypothesized that it can influence: (a) utilization of computers by teachers, and (b) student attitudes towards CAI.

Howard (1986), using 111 corporate managers, found the significant correlates of attitudes about computers to be: (a) computer anxiety (inverse), (b) societal impact attitude (direct), (c) locus of control (internals more favorable), (d) and trait anxiety (inverse).

Okinaka (1992) conducted a correlational study using regression analysis to investigate the factors that affect attitudes of teacher education students towards computer use. His subjects were students enrolled in a basic university computer literacy course. A questionnaire was used to gather data. He found that attitudes are related to: (a) years of experience using computers, (b) interest in and intention to take other computer courses, and (c) personal ownership of a personal computer.

Based on research evidence concerning the relationship of computer experience and attitudes, Delcourt and Kinzie (1993) provided the following summation:

> These outcomes suggest that strategies to enhance teacher experience with computer technologies could contribute to the formation of positive attitudes and

self-efficacy, thus influencing teacher adoption, use, and modeling of computer technologies. (p. 40)

However, some researchers have found that the benefit of experience on improving attitudes about computers depends on how the experience is interpreted by the individual (Campbell & Williams, 1990; Weil, Rosen, & Wugalter, 1990). In a study reported by Raub (1981), students in a computer literacy course became more adverse to computers as the semester progressed despite increases in their computer experiences. Consequently an essential component of a beneficial experience is that it is positively interpreted by the individual. A bad experience can lead to poorer attitudes about computers.

Ertmer, Evenbeck, Cennamo, and Lehman (1994) studied the effects of experience on computer self-efficacy using 32 college students enrolled in a physical education computer applications course. They addressed time-on-task, as a measure of experience, and a positive classroom environment (early, successful experiences followed by positive attributional feedback from the teacher). A direct relationship between experience and levels of confidence was not found, suggesting that quality rather than quantity of computer experience may be the more critical factor. They conclude:

> More importantly, it appears possible to enhance the effect of experience on students' efficacy judgments by situating those experiences within a learning context which provides an acceptable means for voicing frustration and for obtaining encouraging feedback regarding one's developing skills. Given this type of learning context, it does not appear to take an exorbitant amount of time-on-task to affect students' level of confidence. (p. 59)

## Locus of Control

### Theoretical Framework

Motivation is viewed by many educators as an important prerequisite to learning. Students can be motivated to achieve success or to avoid failure. Additionally, they are motivated by what they think caused the success or failure.

Weiner (1979) found that high-achieving students and low-achieving students attribute success to different factors. High achievers attribute success to ability and attribute failure to not trying hard enough. Low-achievers attribute success to fate and attribute failure to lack of ability.

The concept of locus of control (Rotter, 1966) is an important construct in attribution theory. Locus of control refers to the location where control or responsibility is attributed. Internally-oriented people perceive that outcomes

(e.g., success or failure) are the result of their ability, effort, or other internal causes. Externally-oriented people perceive outcomes to be under the control of luck, fate, or other external influences. Rotter believes that locus of control is very important in understanding learning processes and that consistent differences exist among individuals with regard to their locus of control orientations.

<u>Research into Locus of Control</u>

Much of the research with college students shows that they mostly have internal orientations (Rotter, 1966). Evidence from numerous studies suggest a close relationship between internally-oriented subjects and positive academic and attitudinal outcomes (Maehr 1976). Internally-oriented subjects are more perceptive, more eager to learn about their environment, more curious, and more inquisitive (Lefcourt, 1976; Miller & Norman, 1979). Fimian (1988) found internally-oriented subjects have less anxiety-related problems. Howard (1986) describes the results of a study that found subjects with internal orientations tended to use computer systems more than externalizers. On the other hand, externally-oriented subjects give up more easily in the face of frustration and fatigue, and are more passive in the learning process (Miller & Norman, 1979).

Internally-oriented subjects also have their limitations. Extreme internals may attempt to exert total

control over their own outcomes and the outcomes of others. Consequently they may experience considerable frustration and anxiety when placed in a subordinate role (Wong & Sproule, 1984).

The implications of much of the research in locus of control and achievement are that internal locus of control operates in some way to cause better achievement. However, Stipek and Weisz (1981) disagree with this hypothesis. They offer the obvious alternative hypothesis that better achievement produces an internal locus of control. Little of the research in locus of control addresses the causality issue. Most studies are correlational, and they reveal significant relationships between locus of control and achievement, but not causal ones.

## Humanistic Learning

### Introduction

A humanistic learning approach may be an effective treatment in reducing computer anxiety and improving computer attitudes because it addresses many of the considerations identified by the researchers reviewed above, including: (a) computer experience with emphasis on quality rather than quantity (Ertmer, Evenbeck, Cennamo, & Lehman, 1994), (b) opportunities for attitudinal changes including self-efficacy (Rosen & Maguire, 1990), (c) positive outcome expectations (Campbell & Williams, 1990; Schunk, 1989; Weil, Rosen, &

Wugalter, 1990), and (d) learning in the context that provides an acceptable means of voicing frustration and for obtaining encouraging feedback (Ertmer, Evenbeck, Cennamo, & Lehman, 1994).

## Theoretical Framework

Humanistic learning is a noncognitive approach that places emphasis on the effect of emotional and interpersonal behavior on learning. Humanists, in general, believe that education should involve the development of both the intellect and emotions. The goal of this approach is to help develop students' values and self-concepts in concert with academic achievement.

Frank E. Williams (1970) addressed the essence of humanistic education when he wrote:

> Most teachers would agree that thinking processes really cannot operate without feeling processes. Nearly all cognitive behaviors have an affective component. One involves the other, and they cannot be separated. . . . Closely related to a pupil's need for knowledge and information is his preference for an internal set of values and personality dispositions which are nonintellective and comprise the affective domain. Many psychologists and professional educators have argued very strongly that a combination of both domains, cognitive and affective, is what makes for effective

human development and the fully-functioning creative individual. (p. 4)

The concept of humanistic education, which recognized the confluence of affect and cognition in learning processes, has been an element of American education for many years (Brown, 1971). Historically, however, educational objectives have fluctuated from emphasis on cognitive outcomes to major concern with social and affective outcomes (Shavelson, Hubner, & Stanton, 1976).

In 1956, a taxonomy of educational objectives in the cognitive domain published by Bloom, Englehart, Furst, Hill, and Krathwohl (1956) gained immediate popularity and acceptance. The major categories of this taxonomy, in increasing levels of complexity, are: (a) knowledge, (b) comprehension, (c) application, (d) analysis, (e) synthesis, and (f) evaluation.

An affective taxonomy of educational objectives by Krathwohl, Bloom, and Masia (1964) also gained wide acceptance. This taxonomy advocated that, just as there are levels of complexity of behavior in the cognitive domain, there are also levels of complexity of behavior in the affective domain. These levels were referred to as degrees of internalization. The major categories in the affective domain, from the lowest level of learning outcomes to the highest, are: (a) receiving, (b) responding, (c) valuing, (d)

organization, and (e) characterization by a value or value complex.

Relationship to Howard's Theoretical Framework

Howard's (1986) theory of computer anxiety suggests that computer anxiety has operational, knowledge, and psychological roots. A cognitive learning approach addresses the operational and knowledge roots, but leaves the psychological roots untreated. Similarly, an affective domain approach addresses only the psychological roots. Humanistic learning theory provides for a treatment that includes learning outcomes from both the cognitive and affective domains.

The cognitive domain component of humanistic learning theory addresses: (a) the application skills necessary to overcome operational fears (i.e., the inability to make the computer perform as desired because of the lack of skills); and (b) the knowledge and comprehension necessary to overcome knowledge-based fears (i.e., the inability to understand why the computer behaves as it does).

The psychological roots of computer anxiety are more complex. Raub (1981) provides insight into this complexity in discussing the results of her clinical interviews with computer anxious college students:

> The computer-anxious students shared a background of alienation or isolation from technology. The computer

> explosion of the past decade passed by them unnoticed. They described a kind of "Rip van Winkle" experience: Where have I been during these past 10 years when the computer revolution was taking place? It is from this obliviousness to technology that computer anxiety appears to originate.
>
> The interviews further suggested that lack of computer experience may not be a _cause_ of computer anxiety; rather, it may be the _result_ of feeling alienated from technology. This alienation inhibits interaction with computers, even where interaction opportunities exist. (p. 100)

The affective domain component of humanistic learning theory can address the individual's fundamental beliefs and attitudes about technology in general and computers in particular. The higher levels of learning outcomes can address the feelings of alienation from technology described by Raub.

It would therefore appear that a humanistically-focused treatment can effectively treat the roots of computer anxiety and improve attitudes about computers. The treatment should include knowledge-, comprehension-, and application-level learning outcomes from the cognitive domain and higher-level learning outcomes from the affective domain.

## Research Hypotheses

The following null hypotheses, by research question, were tested in this study.

### Research Question Number 1

There are no changes in the computer anxiety and the computer attitudes of urban teacher education students over time as the result of a computer literacy course.

### Research Question Number 2

Computer experience, computer knowledge, trait anxiety, locus of control and the attitudes of computer confidence, computer liking, and computer usefulness do not provide significant contributions to the prediction of the retained computer anxiety of urban teacher education students at the end of a computer literacy course.

### Research Question Number 3

Since a two-way factorial design was used for this research question, three null hypotheses were tested. Hypotheses number 1 and number 2 pertain to main effects and hypothesis number 3 pertains to the interaction effect.

Hypothesis Number 1. There are no differences between a humanistically-focused computer literacy course and a cognitively-focused course in reducing the computer anxiety and improving the computer attitudes of urban teacher education students.

Hypothesis Number 2. A computer literacy course taught by different instructors results in no differences in the computer anxiety and computer attitudes of urban teacher education students.

Hypothesis Number 3. The effects of type of treatment on the computer anxiety and the computer attitudes of urban teacher education students do not differ based on different instructors.

# CHAPTER III

# METHODOLOGY

## Introduction

This chapter describes: (a) the characteristics of the research location that are relevant to this study; (b) the population and sampling procedures; (c) the two treatment types used for research question number 3; (d) test instruments, including evidence of reliability and validity, and the test schedule; (e) the purpose and objectives of the pilot study; (f) variables, including their operational definitions; (g) the research designs used for each research question and their implementation procedures; (h) the statistical procedures used to analyze data; (i) the threats to internal and external validity and the actions taken to control these threats; and (j) the direct observation protocol implemented for research question number 3.

## Research Location

Research was conducted at the Darden College of Education, Old Dominion University, a state university located in an urban setting on a 146-acre campus in Norfolk, Virginia's second largest city. The city's population is 261,229 with a metropolitan area population of 1,396,107 (1990 census). Norfolk is one of the world's largest coal ports and is a leading Atlantic port in export tonnage. The Norfolk Naval and Naval Air stations, together with the

Norfolk Naval Shipyard in Portsmouth, constitute the world's largest operating naval base.

## Population and Sample

The target population for this study was teacher education students in an urban university environment. The experimentally accessible population was teacher education students attending Old Dominion University. The sample used in this study consisted of students enrolled in ECI 304, Educational Applications of Technology.

All sections of this course conducted during the summer 1995 semester provided the subject pool for the pilot study. Designated sections of this course conducted during the 1995-96 school year provided subjects for the main study. Specifically, all six sections of the course conducted during the fall 1995 semester provided subjects for research questions number 1 and number 2. Four (out of five) randomly selected sections of the course conducted during the spring 1996 semester provided subjects for research question number 3.

Since ECI 304 is a required course for teacher education students at Old Dominion University, the assumption was made that members of the sample are representative of the experimentally accessible population. Therefore, study results can be generalized to the accessible population.

Subject participation in this study was voluntary. Each section of ECI 304 received similar study orientations (see Appendix A). Each student who volunteered was required to complete a Subject Consent Form (see Appendix B). In order to improve the volunteer rate, the following actions were taken as recommended by Rosenthal and Rosnow (1975):

1. The appeal for volunteers was made as nonthreatening as possible. Confidentiality of data was stressed.
2. The theoretical and practical importance of the study was emphasized.
3. The responsibility of potential volunteers to participate in research that has the potential for benefiting others was highlighted.
4. To the maximum extent possible, study requirements imposed on volunteers were brief and were conducted during normal class time.
5. Volunteers participating in the time-series study who were required to complete a delayed test observation on their own time were offered $5.00 as an incentive.

The following categories of students enrolled in ECI 304 were not eligible for participation in the study:

1. Students who did not complete the Subject Consent Form (see Appendix B) were not eligible. This category was selected to satisfy university requirements.

2. Students below age 18 at the start of the study were not eligible. This category was selected to avoid problems involving parental consent for minors.

3. Students who were concurrently enrolled in another computer literacy course during the study were not eligible. This category was selected to help ensure that any changes in test scores involved only the treatments under study.

4. Students who were not enrolled in a teacher education program were not eligible. This category was selected because the study was limited to teacher education students.

5. Students who expressed the intent of not remaining at the university during the spring semester were not eligible. This category was selected because the study extended into the spring semester and required subjects to remain accessible to the researcher.

6. Students who were repeating ECI 304 were not eligible. This category was selected because a repeated course might affect a student's anxiety and attitudes in a unique manner.

Students who were not eligible to participate in the study or who did not volunteer for the study were asked to complete an anonymous Start-of-Study Questionnaire in order to collect background information. Chapter IV provides the results of a check for bias between volunteers and nonparticipants using the data from the Start-of-Study Questionnaire.

# Treatments

## Introduction

Two semester-long instructional treatments were utilized in this study: a cognitively-focused treatment and a humanistically-focused treatment. Detailed plans for these two treatments, which consist of course instructor guidance, goals, learning outcomes, and experiences, can be found in Appendixes C and D respectively.

Appendix E and F are the syllabi for the two treatments, which include student guidance, major course requirements, and a weekly course outline by treatment.

The intent of these plans and syllabi were: (a) to document the two treatments in sufficient detail to facilitate treatment fidelity, (b) to distinguish the two treatments, and (c) to permit treatment and study replication.

Both treatments addressed similar computer competencies, although not necessarily at the same levels of learning. These competencies were based on the topics traditionally taught in ECI 304 as harmonized with the technology-related competencies for teacher education programs identified by R. J. Beichner (1993).

Course instructors used three general methods of instruction to teach the two treatment types:

1. Presentation method: included lecture (formal or informal presentation of information, concepts, or principles by a single individual, with or without questioning), panel discussion, demonstration-performance (presentation or portrayal of a sequence of events to show a procedure), reading (books, periodicals, handouts, etc.), and self-paced (programmed instruction).
2. Verbal interaction method: questioning and discussion, included guided discussion (teacher-facilitated interactive process of sharing information, experiences, and feelings) and nondirected discussion (such as peer-controlled group discussion).
3. Application method: provided learners with opportunities to apply learned material, e.g., using a computer. Included individual and group projects, case studies (including discussion), and simulations (e.g., role-playing and games).

The two treatments differed along the following three dimensions:

1. The planned learning outcomes of the cognitively-focused treatment were exclusively from the cognitive domain (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and the planned learning outcomes of the humanistically-focused treatment were from both the cognitive and affective domains (Krathwohl, Bloom, & Masia, 1964).

2. The cognitively-focused treatment placed emphasis on presentation and application teaching methods to achieve its learning outcomes. The humanistically-focused treatment placed emphasis on verbal interaction and application teaching methods to achieve its learning outcomes.
3. The cognitively-focused treatment placed emphasis on teacher-initiated cognitive interactions (e.g., how do you copy a file?). The humanistically-focused treatment placed emphasis on teacher-initiated affective interactions (e.g., how important is this lesson to you?).

Cognitively-Focused Treatment

The cognitively-focused treatment is defined as the university computer literacy course that adheres to the plan in Appendix C and the syllabus in Appendix E. Its stated learning outcomes are exclusively from the cognitive domain as defined by Bloom, Englehart, Furst, Hill, and Krathwohl (1956). The focus of this treatment was on the recall or recognition of knowledge and the development of intellectual abilities and skills and, as such, explicitly addressed two of Howard's (1986) three sources of computer anxiety: (a) lack of operational experience, and (b) inadequate knowledge about computers.

Humanistically-Focused Treatment

The humanistically-focused treatment is defined as the university computer literacy course that adheres to the plan

in Appendix D and the syllabus in Appendix F. Its stated learning outcomes are from both the cognitive domain (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and the affective domain (Krathwohl, Bloom, & Masia, 1964). By maintaining consistency with humanistic learning theory, this treatment placed emphasis on: (a) computer experiences with emphasis on quality rather than quantity, (b) positive outcome expectations, and (c) learning in the context that provides an acceptable means of voicing frustration and for obtaining encouraging feedback.

Like the cognitively-focused treatment, this treatment was designed to provide computer knowledge, skills, and hands-on experience using the computer. Additionally, it included affective domain learning outcomes to enable subjects to: (a) believe that positive outcomes will result from use of computer technology in the classroom, (b) value these outcomes, and (c) possess high confidence in their abilities to use computers.

With the inclusion of both cognitive and affective domain learning outcomes, this treatment explicitly addressed all three of Howard's (1986) sources of computer anxiety: (a) lack of operational experience, (b) inadequate knowledge about computers, and (c) psychological factors.

As attitudes have both cognitive and affective components, the cognitive domain learning outcomes were

formulated to address the affective component of attitudes about computers whenever possible. For example, a unique cognitive domain learning outcome for this treatment was that students summarize the impact of computer technology on education. Student achievement of this objective addressed the intellectualization needed for students to achieve a related affective domain learning outcome: the belief that positive outcomes can result from use of computer technology in the classroom.

To devote time to the affective domain learning outcomes, some cognitive domain objectives in this treatment addressed lower levels of learning than similar learning outcomes in the cognitive treatment. For example, in the cognitive treatment, subjects were brought to the application level of learning in using word processing, database management, desktop presentation, and spreadsheet software. However, in the humanistically-focused treatment, using word processing and desktop presentation software were addressed at the application level of learning while using database management and spreadsheet software were taught at the comprehension level of learning. Despite these differences, the humanistically-focused treatment maintained a strong performance orientation in order to build computer confidence through performance accomplishments.

# Instrumentation

## Introduction

Instrumentation for this study consisted of six self-report questionnaires: (a) the Computer Anxiety Scale (COMPAS), (b) the Computer Attitude Scale (CAS), (c) the Start-of-Study Questionnaire, (d) the End-of-Study Questionnaire (e) Rotter's Internal-External (I-E) Control Scale, and (f) the Trait Form of the State-Trait Anxiety Inventory (STAI). Each of these instruments are described in detail in the following paragraphs.

## Computer Anxiety Scale (COMPAS)

The COMPAS (Oetting, 1983) is a self-report scale that was used to operationalize computer anxiety. It consists of a long form with 48 items and parallel form A and parallel form B, each containing 24 items. The two parallel forms administered together comprise the long form. For each item the test utilizes a statement followed by a Semantic Differential scale consisting of adjective pairs, with each adjective as an end anchor in a single five point continuum. For example, the first statement in the test instrument is just being around a computer, with a five-point continuum anchored by the terms calm and tense.

COMPAS items are each given a weighted score of 1 to 5 based on the test key which are then added to obtain the overall score. Scores range from 40 to 200 using the long

form and 20 to 100 using either of the two parallel forms with higher scores reflecting greater computer anxiety.

Oetting (1983) reports a Cronbach alpha reliability of .96 for the long form and .93 for each of the two parallel forms.

The test manual includes profiles for general computer anxiety as measured by the COMPAS. These profiles identify approximate scores for: (a) very anxious, (b) anxious/tense, (c) some mild anxiety present, (d) generally relaxed/comfortable, and (e) very relaxed/confident.

Oetting provides considerable evidence that the COMPAS is a valid measure of computer anxiety. A study of 279 college students shows the following relationships between computer anxiety, as measured by the COMPAS, and various test anxieties: (a) computer test anxiety, $r$ = .70; (b) math test anxiety, $r$ = .40; (c) science test anxiety, $r$ = .48; and (d) theme or term paper anxiety, $r$ = .19. These results are consistent with an instrument that possesses both convergent and discriminant validity. Oetting concluded that computer anxiety is highly related to computer test anxiety and less so to other forms of test anxiety.

Writing for the Tenth Mental Measurements Yearbook, Kleinmuntz (1989) states "if it is important to measure or predict computer anxiety, then Oetting's Computer Anxiety Scale (COMPAS) is certainly the test to select" (p. 570).

For the pilot study, the COMPAS long form was used in order to obtain equivalency data on the two parallel forms. For the main study, parallel form A and parallel form B were used in order to avoid the practice effect by repeatedly administering the same questionnaire.

Parallel form A and parallel form B were selected on a random basis for each subject at each testing session in order to protect against a pattern effect in the statistical analysis.

Computer Attitude Scale (CAS)

The CAS (Gressard & Loyd, 1985) measured the degree to which subjects: (a) were anxious about computers, (b) had confidence in their abilities to use computers, (c) viewed computers as useful, and (d) liked using computers. The test utilizes the Likert scale consisting of 10 statements and the same four choices for each attitude measured. Respondents indicate the degree of agreement or disagreement with each statement. For example, an item that measures computer confidence in the test instrument starts out with the statement I'm no good with computers, followed by the choices strongly agree, slightly agree, slightly disagree, and strongly disagree.

Each CAS item is given a weighted score of 1 to 4 based on the test key. Item scores are then added to obtain the score for each scale. Scores can range from 10 to 40. Higher

scores reflect lower degrees of computer anxiety and higher degrees of computer confidence, computer usefulness, and computer liking.

Loyd and Loyd (1985) report Cronbach alpha reliabilities of .89, .89, .89, and .82 respectively for the scales of computer anxiety, computer confidence, computer usefulness, and computer liking in a population of 114 teachers from kindergarten to grade twelve. Ages of the subjects ranged from 23 to 60 years. Thirty-three of the subjects were male and 81 were female.

Validation studies (Loyd & Gressard, 1984; Gressard & Loyd, 1985) provide substantial evidence that the CAS is a valid measure of computer attitudes and that it can be confidently and effectively utilized in research. Included in the evidence is validation by judges' ratings and the factor analysis of the ratings of 155 subjects.

Gardner, Discenza, and Dukes (1993) conducted a study to investigate the relative reliability and construct validity of four measures of attitudes about computers. They examined the Attitudes Towards Computers (ATC) scale (Raub, 1981), the CAS, the Computer Anxiety Index (CAIN) (Maurer & Simonson, 1984), and the Bloomberg-Lowery Computer Attitude Task (BELCAT). Subjects were 244 undergraduate students enrolled in eleven courses at a medium-sized university. They concluded that none of the four measures and their subscales

appeared superior. That is, comparable subscales had approximately equal and high reliabilities. The same was true for concurrent validity. Attempts to improve the original measures as part of the study were unproductive. Based on their review of the literature, they found evidence that the CAS is becoming the measure of choice in research on attitudes about computers. They state "if researchers are interested in comparing results of their studies to those of others, the CAS may be developing into a standard measure" (p. 501) for attitudes about computers.

The CAS was used in this study to operationalize the dependent variables of computer confidence, computer usefulness, and computer liking. The computer anxiety scale of the CAS was not used because the COMPAS was better suited to measure computer anxiety for this study because it included parallel forms.

Start-of-Study Questionnaire

The Start-of-Study Questionnaire (see Appendix G) was developed by the researcher and administered to all subjects in order to: (a) help control study mortality by obtaining subject names, phone numbers, and local addresses; (b) provide insights into subject backgrounds and characteristics; and (c) measure computer experience and computer knowledge using interval scales.

The Start-of-Study Questionnaire elicited the following demographic information: (a) name, (b) local address and telephone number, (c) sex, (d) age, (e) academic major, (f) personal ownership of a computer, (g) extent of computer knowledge and experience, and (h) concurrent enrollment in other courses that use computers.

Of particular importance to the main study was the Computer Experience Scale and Computer Knowledge Scale developed by the researcher.

The Computer Experience Scale consists of two items (number 11 and number 12) from the Start-of-Study Questionnaire. The subscore for each item ranges from 0 (no computer experience) to 5 (considerable computer experience). For item number 11, the subject selects the typical number of hours per week of computer usage. This entry is assigned a graduated subscore ranging from 0 (0 hours per week) to 5 (greater than or equal to 8 hours per week). For item number 12, the subject selects the length of time of regular computer usage. This entry is assigned a graduated subscore of 0 (not at all) to 5 (over 3 years). The total score for the variable is obtained by multiplying the subscores obtained from the two items. The total possible score ranges from 0 (no computer experience) to 25 (considerable computer experience).

The Computer Knowledge Scale consists of a single item (number 13) with 11 parts from the Start-of-Study Questionnaire. The subject enters a subscore that ranges from 0 (no knowledge) to 3 (considerable knowledge) for each of the following computer knowledge areas: computer networks, computer programming, database management programs, desktop presentation programs, desktop publishing programs, entertainment/games, multimedia/hypermedia programs, spreadsheet programs, telecommunications, and word processing programs. The total score is obtained by adding all the responses entered by the subject. Scores for this scale range from 0 (no computer knowledge) to 33 (considerable computer knowledge).

An objective of the pilot study was to obtain reliability data for these two scales. Consequently the findings regarding the reliability of these two scales are contained in the pilot study section of Chapters IV.

The Computer Experience Scale and Computer Knowledge Scale were assessed by the researcher to have high face validity. The Computer Experience Scale incorporates two important elements of computer usage: breadth (typical computer usage per week) and length (how long the subject has been regularly using computers). The Computer Knowledge Scale addresses the eleven computer knowledge areas identified by Lockard, Abrams, and Many (1994).

Descriptive phrases used to elicit subject responses for both scales were obtained from a study by Matthews, Wright, and Yudowitch (1975) that examined degrees of adequate and inadequate by phrase, mean, and standard deviation.

The content validity of these two scales was assessed to be reasonably high by a panel of experts. Three professors who teach educational technology courses at Old Dominion University were selected as experts in educational computer technology and agreed to assess content validity. Each expert independently rated the relevance of each item on each scale using a graduated 4-point scale consisting of totally not relevant, barely relevant, reasonably relevant, and totally relevant.

Based on this procedure, the mean score for each item of the Computer Experience Scale was 4.0, meaning that all three professors regarded each item of this scale to be totally relevant.

The mean score for each item of the Computer Knowledge Scale ranged from a high of 4.00 for word processing, to a low of 3.33 for networks, spreadsheet programs, and telecommunications. Therefore, the Computer Knowledge Scale received mean ratings between 3 (reasonably relevant) and 4 (totally relevant).

Table 1 shows the mean, minimum, and maximum ratings for each item of the Computer Knowledge Scale.

Table 1

Computer Knowledge Scale Item Ratings by Experts

| Item | M | Minimum | Maximum |
|---|---|---|---|
| Computer programming | 3.67 | 3 | 4 |
| Database management programs | 3.67 | 3 | 4 |
| Desktop presentation programs | 3.67 | 3 | 4 |
| Desktop publishing programs | 3.67 | 3 | 4 |
| Entertainment/games | 3.67 | 3 | 4 |
| Graphics programs | 3.67 | 3 | 4 |
| Multimedia/hypermedia programs | 3.67 | 3 | 4 |
| Networks | 3.33 | 2 | 4 |
| Spreadsheet programs | 3.33 | 2 | 4 |
| Telecommunications | 3.33 | 2 | 4 |
| Word processing programs | 4.00 | 4 | 4 |

Note. The rating scale goes from a high of 4 (totally relevant) to a low of 1 (totally not relevant).

End-of-Study Questionnaire

The End-of-Study Questionnaire (see Appendix H) was developed by the researcher and administered to subjects in order to help control for history threats to validity, to determine the intent of subjects to use computers, and to measure posttest computer experience and computer knowledge.

The End-of-Study Questionnaire elicited information concerning: (a) involvement in other significant computer

activities during the study; (b) use of outside help, such as tutors; (c) how the treatment satisfied or did not satisfy expectations; (d) intentions of using computers as a classroom teacher; and (e) computer experience and knowledge.

Rotter's Internal-External (I-E) Control Scale

Rotter's I-E Control Scale (Rotter, 1966) is a 29-item, forced-choice test. It includes six filler items intended to make the purpose of the test more ambiguous. It provides a single measure of the extent to which subjects hold generalized control beliefs. Each item consists of two choices: an internal choice and an external choice. For example, one test item is "a. People's misfortunes result from the mistakes they make. b. Many of the unhappy things in people's lives are partly due to bad luck" (Rotter, 1966, p. 11). The external response is choice b. The score is the total number of external choices. Scores range from 0 to 23. Lower scores reflect stronger internality and higher scores reflect stronger externality.

Rotter (1966) reports an internal consistency coefficient (Kuder-Richardson 20) of .70 obtained from a sample of 400 college students. Test-retest reliability for a one month period using 60 college students was .72 (Rotter, 1966). In another study, a coefficient of internal consistency was found to be .76 using split-half correlation (Anderson, 1977).

Rotter (1966) also provides evidence of discriminant validity and a description of the results of several studies of construct validity.

Stipek and Weisz (1981) assert that Rotter's I-E Control Scale is the most common measure of locus of control in a school environment. Rotter's I-E Control Scale was used in this study to obtain a measure of generalized control beliefs that was used as a possible predictor variable for posttest computer anxiety in research question number 2.

State-Trait Anxiety Inventory (STAI)

The STAI (Spielberger, 1983) comprises separate self-report scales for measuring state and trait anxiety. The state form evaluates how subjects feel at the time of test administration, whereas the trait form assesses how subjects generally feel. Only the trait form of the STAI was used in this study. Each form of the STAI utilizes a Likert scale consisting of 20 statements, each with the same four choices. Respondents indicate the degree of agreement or disagreement with each statement. For example, one trait form item states I feel pleasant, followed by the choices almost never, sometimes, often, and almost always.

Each trait form item is given a weighted score of 1 to 4. Scores can vary from a minimum of 20 to a maximum of 80, with higher scores reflecting higher levels of trait anxiety.

The test manual includes a procedure for adjusting the total score if up to two items are unanswered.

The STAI is a unidimensional instrument because it only assesses proneness to ego threat situations and does not address physical threat situations (Endler, 1980). However, this limitation should have no impact on this study as computers do not present a physical threat.

Spielberger (1983) reports trait form Cronbach alpha reliabilities of .90 and .91 respectively for male ($\underline{N}$ = 324) and female ($\underline{N}$ = 531) college students. Additionally, he reports test-retest reliabilities of .73 and .77 respectively for male and female college students over a six-month period.

The validity of both scales have been demonstrated in a wide variety of studies which report consistent findings regarding the concurrent, convergent, divergent, and construct validity of the STAI scales in the following areas: (a) contrasted groups, (b) correlations of the trait anxiety scale with other measures of trait anxiety, (c) correlations of the STAI scales with other widely used measures of personality and adjustment, (d) correlations of the STAI scales with measures of academic aptitude and achievements, and (e) investigations of the effects of different amounts and types of stress on state anxiety scores (Spielberger, 1983).

The following correlation coefficients show state and trait construct validity to other tests that purport to measure similar constructs: (a) the Taylor Manifest Anxiety Scale, $\underline{r}$ = .80 (Taylor, 1953); and (b) the ITAP Anxiety Scale, $\underline{r}$ = .75) (Cattell & Scheir, 1963).

Levitt (1967) states "The STAI is the most carefully developed instrument, from both theoretical and methodological standpoints. The test construction procedures described by Spielberger and Gorsuch are highly sophisticated and rigorous" (p. 71).

The STAI trait form was used in this study to obtain a measure of trait anxiety that was used as a possible predictor variable for posttest computer anxiety in research question number 2.

## Pilot Study

### Objectives

A pilot study was conducted during the summer 1995 semester using volunteers enrolled in ECI 304. The objectives of this study were to: (a) improve test administration procedures and the locally developed instruments; (b) assess volunteer and mortality rates; (c) demonstrate the reliability of all scales used in the main study; (d) determine whether the presence of computers affected measurements of computer anxiety; (e) ascertain levels of computer anxiety and attitudes about computers; and (f)

conduct preliminary testing of the research hypothesis for research question number 2.

Rationale

The pilot study was essential for the development of a sound research plan and for providing ideas, insights, and clues not previously foreseen.

The rationale for improving test administration procedures was to ensure the adequacy of: (a) the subject orientation (see Appendix A), (b) testing directions, and (c) time allotted to complete the questionnaires. In particular, it was necessary to ensure the Start-of-Study and End-of-Study Questionnaires, which were developed locally and never tested, were clear and unambiguous.

Assessments of volunteer and mortality rates were required in order to determine if additional actions were required for the main study in order to obtain higher volunteer rates and lower mortality rates.

Reliability analyses were required to ensure that the scales used in this study, particularly the two locally developed scales, were sufficiently reliable for use in the main study.

The pilot study also determined whether the main study would provide a suitable stimulus for computer anxiety to manifest itself during the measurement of computer anxiety. Three conditions were examined: (a) completing the standard

written form of the COMPAS without computers present, (b) completing the standard written form of the COMPAS with computers present, and (c) using computers to complete the COMPAS. This issue was particularly relevant to the time-series design of research question number 1. The researcher estimated that high mortality would occur if subjects were required to return to the computer laboratory 13 weeks after completing the treatment for the delayed test observation. If completing the COMPAS without computers present provided sufficient stimulus for computer anxiety to manifest itself, then the mail could be used for the delayed test observation.

The pilot study also examined the pretest and posttest levels of computer anxiety and attitudes about computers in subjects drawn from the experimentally accessible population. Such information could provide possible insight regarding the scope of the problem in the target population and the suitability of the variables used.

Finally, preliminary testing of the hypothesis for research question number 2 could lead to testing a more precise hypothesis in the main study. Only preliminary testing of research question number 2 was feasible because the duration of the pilot study precluded conducting a longitudinal study (research question number 1), and the absence of a humanistically-focused treatment during the

summer semester precluded a comparison group study (research question number 3).

## Test Schedule

Test instruments were administered to subjects as shown in Table 2. For each test administration, all applicable test instruments were assembled and administered as a consolidated test battery. Both the Start-of-Study Questionnaire and the End-of-Study Questionnaire included the Computer Experience Scale and the Computer Knowledge Scale.

Table 2

Test Schedule

| | Pilot study | | Main study | | |
|---|---|---|---|---|---|
| Questionnaire | Pretest | Posttest | Pretest | Posttest | Delayed test |
| Start-of-Study | X | | X | | |
| CAS | X | X | X | X | X |
| COMPAS | X | X | X | X | X |
| I-E Control Scale | X | X | X | | |
| STAI Trait Form | X | X | X | | |
| End-of-Study[a] | | X | | X | X |

Note. [a]The End-of-Study Questionnaire was only administered during the delayed test observation for research question number 1.

Questionnaires were administered during both the pretest and posttest observations of the pilot study in order to collect test-retest reliability data.

## Variables

### Introduction

Operational definitions of the primary variables used in this study are provided below. Additional variables used in this study (e.g., variables used in secondary analyses of data such as tests of assumptions) are defined where they are used.

### Interval Scale Variables

Computer anxiety. Computer anxiety is operationally defined as the general measure generated by the COMPAS (Oetting, 1983). This variable reflects the degree to which subjects are anxious about computers. Higher scores reflect greater computer anxiety. Computer anxiety was used in all research questions.

Computer confidence. Computer confidence is operationally defined as the measure generated by the respective subscale of the CAS (Gressard & Loyd, 1985). This variable reflects the degree to which subjects have confidence or self-efficacy in their abilities to use computers and was used in all research questions.

Computer experience. Computer experience was measured twice and is operationally defined as the measure generated

from items number 11 and number 12 of the Start-of-Study Questionnaire and items number 10 and 11 of the End-of-Study Questionnaire. This variable provides an estimate of a subject's experience with computers by considering both the breadth (first item) and length (second item) of computer experience. Computer experience was used in research question number 2.

Computer knowledge. Computer knowledge was measured twice and is operationally defined as the measure generated from item number 13 of the Start-of-Study Questionnaire and item number 12 of the End-of-Study Questionnaire. This variable reflects the degree of the subject's computer knowledge and was used in research question number 2.

Computer liking. Computer liking is operationally defined as the measure generated by the respective subscale of the CAS. This variable reflects the degree to which subjects like to use computers and was used in all research questions.

Computer usefulness. Computer usefulness is operationally defined as the measure generated by the respective subscale of the CAS. This variable reflects the degree to which subjects view computers as useful and was used in all research questions.

Locus of control. Locus of control is operationally defined as the measure generated by Rotter's I-E Control

Scale (Rotter, 1966). Higher scores reflect a more external orientation while lower scores reflect a more internal orientation. This variable was used in research question number 2.

Trait anxiety. Trait anxiety is operationally defined as the measure generated by the STAI trait form (Spielberger, 1983). Higher scores reflect higher trait anxiety. This variable was used in research question number 2.

Nominal Scale Variables

Course instructor. Course instructor (two levels: instructor number 1 and instructor number 2) is operationally defined as the two instructors who taught ECI 304 during the spring 1996 semester. Both instructors were adjunct faculty members holding Virginia teaching credentials. This variable was used in research question number 3.

Observation. Observation (three levels: pretest observation, posttest observation, and delayed test observation) is operationally defined as follows: (a) pretest observation occurred at the start of the study during the second week of the fall 1995 semester, (b) posttest observation occurred 13 weeks after the pretest observation at the end of the fall 1995 semester, and (c) delayed test observation occurred 13 weeks after the posttest observation. This variable was used in research question number 1.

Treatment type. Treatment type (two levels: cognitively-focused treatment and humanistically-focused treatment) is operationally defined as either the cognitively-focused treatment (see Appendix C) or the humanistically-focused treatment (see Appendix D) based on treatment exposure. This variable was used in research question number 3.

## Design

### Research Question Number 1

What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?

A single-group interrupted time-series design was used to respond to this research question in order to assess patterns of stability and change. Campbell and Stanley (1963) regard this type of design as quasi-experimental. The subject pool consisted of all six sections of ECI 304 conducted during the fall 1995 semester.

The independent variable was observation (three levels: pretest observation, posttest observation, and delayed test observation). The dependent variables were computer anxiety, computer confidence, computer usefulness, and computer liking.

In this design, a change from the pretest observation to the posttest observation provides evidence of treatment

effects. A change from the posttest observation to the delayed test observation addresses the durability of the treatment effects.

The following conditions for the use of a time-series design were met:

1. Observations were made at equal time intervals (13 weeks).
2. All observations were conducted using the same procedures.
3. The treatment was a distinctive intervention.
4. The same subjects were involved in each observation.

The following procedures were used:

1. The Start-of-Study Questionnaire, CAS, COMPAS, trait form of the STAI, and Rotter's I-E Control Scale were administered to all subjects enrolled in ECI 304 (pretest observation) during the second week of the fall 1995 semester. Parallel forms A and B of the COMPAS were chosen on a random basis for each subject in order to protect against a pattern effect in the statistical analysis and a practice effect in the repeated COMPAS measurements.
2. All subjects were exposed to ECI 304.
3. The COMPAS and the CAS were administered to all subjects at the end of the semester prior to the final course examination (posttest observation). Parallel forms A and B of the COMPAS were again chosen on a random basis for each subject. Subjects were also asked to verify the addresses

that would be used to distribute the delayed test questionnaires by mail.

4. Thirteen weeks later, the CAS, COMPAS, and End-of-Study Questionnaire were mailed to all subjects as the delayed test observation. Again, parallel forms A and B of the COMPAS were chosen on a random basis for each subject.

5. Subjects who did not return the delayed test questionnaires within one week were contacted by telephone to encourage study completion.

6. A $5.00 check was mailed to each subject who returned the completed delayed test questionnaires.

7. The data were analyzed.

Research Question Number 2

Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the end of a computer literacy course and what optimum weight should be associated with each predictor?

Multiple regression was used for this question in order to explain and to predict posttest computer anxiety based on a set of predictor variables. Basically, a regression equation was sought so that on the basis of the subject's status on a set of predictors, his or her level on the criterion variable could be predicted.

The predictor variables were locus of control and trait anxiety measured at the pretest observation and computer

confidence, computer experience, computer knowledge, computer liking, and computer usefulness measured at the posttest observation. All predictor variables were selected on the basis of theoretical considerations. Since locus of control and trait anxiety were not expected to vary significantly during one's lifetime (Gaudry & Spielberger, 1971; Rotter, 1966), they were measured at the pretest observation in order to help balance testing time between observations. The criterion variable, measured at the posttest observation, was computer anxiety at the end of a computer literacy course.

The following procedures were used:

1. The Start-of-Study Questionnaire, trait form of the STAI, and Rotter's I-E Control Scale were administered to all subjects enrolled in ECI 304 at the start of the fall 1995 semester in order to measure the following predictor variables: locus of control and trait anxiety.
2. All subjects were exposed to a computer literacy course (ECI 304).
3. The CAS and items number 10, 11, and 12 from the End-of-Study Questionnaire were administered to all subjects at the end of the semester in order to measure the remaining predictor variables: computer confidence, computer experience, computer knowledge, computer liking, and computer usefulness.

4. The COMPAS was administered to all subjects at the end of the semester in order to measure the criterion variable. Parallel forms A and B of the COMPAS were chosen on a random basis for each subject.

5. The data were analyzed with the objective of developing a regression equation.

6. The Start-of-Study Questionnaire, trait form of the STAI, and Rotter's I-E Control Scale were administered to all subjects enrolled in ECI 304 at the start of the spring 1996 semester. This was done to measure locus of control and trait anxiety for the purpose of conducting cross-validation with a new sample.

7. Subjects were exposed to either the cognitively-focused treatment or the humanistically-focused treatment.

8. The CAS and End-of-Study Questionnaire were administered to all subjects at the end of the semester in order to measure the remaining predictor variables: computer confidence, computer knowledge, computer experience, computer liking, and computer usefulness.

9. The COMPAS was administered to all subjects at the end of the semester in order to measure the criterion variable. Parallel forms A and B of the COMPAS were again chosen on a random basis for each subject.

10. The data were analyzed with the objective of cross-validating the regression equation with a new sample of subjects.

Research Question Number 3

How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and teacher?

A quasi-experimental pretest-posttest comparison group design was used for this research question. The treatment group was exposed to the humanistically-focused treatment and the comparison group was exposed to the cognitively-focused treatment. The subject pool consisted of four sections of ECI 304 conducted during the spring 1996 semester. Two different instructors were utilized. Each instructor taught one humanistically-focused treatment and one cognitively-focused treatment.

The independent variables were: (a) treatment type (two levels: cognitively-focused treatment and humanistically-focused treatment); and (b) course instructor (two levels: instructor number 1 and instructor number 2).

The dependent variables were computer anxiety, computer confidence, computer usefulness, and computer liking.

The results of treatment effects are of interest in order to obtain evidence regarding the relative efficacy of the two treatments in reducing computer anxiety and improving

computer confidence, computer liking, and computer usefulness.

The results of course instructor effects are of interest in order to obtain evidence regarding the relative efficacy of different instructors in reducing computer anxiety and improving computer attitudes after controlling for treatment type. Nonsignificant course instructor effects would provide evidence that treatment results are not sensitive to the instructor. Significant main or Treatment x Course Instructor effects would provide evidence that treatment results are sensitive to the instructor.

The following procedures were used:

1. Four sections of ECI 304 scheduled for the spring 1996 semester were randomly divided into two cognitively-focused treatment groups and two humanistically-focused treatment groups.
2. Two course instructors were selected. Each instructor was assigned to teach one cognitively-focused treatment and one humanistically-focused treatment.
3. Course instructors were trained in the two treatments by the researcher using the treatment plans (see Appendixes C and D) and the treatment syllabi (see Appendixes E and F).
4. The Start-of-Study Questionnaire, CAS, COMPAS, trait form of the STAI, and Rotter's I-E Control Scale were administered to all subjects at the pretest observation. Parallel forms A

and B of the COMPAS were chosen on a random basis for each subject.

5. Two sections of ECI 304 were exposed to the cognitively-focused treatment and two sections of ECI 304 were exposed to the humanistically-focused treatment.

6. Instructors maintained a daily journal for each treatment using the format specified in Appendixes C and D. The journal was sent to the researcher each week via electronic mail..

7. A direct observation protocol was implemented during the semester consisting of random implementation checks of each treatment in order to help control for treatment fidelity. Two trained independent observers completed observation reports for each class checked (see Appendix I).

8. The researcher examined journal and observation report entries each week and compared these entries to the treatment plans (see Appendixes C and D) and treatment syllabi (see Appendixes E and F). Feedback was provided the instructors via electronic mail in order to help ensure both treatments adhered to the appropriate treatment plans and syllabi.

9. All ECI 304 sections were administered the CAS, COMPAS, and End-of-Study Questionnaire at the end of the semester. Parallel forms A and B of the COMPAS were chosen on a random basis for each subject.

10. The data were analyzed.

# Data Analysis

## Introduction

Background. All statistical analyses were conducted using Statistical Packages for the Social Sciences (SPSS), version 6.1.1 (Norusis, 1994). The .05 level of significance was used for all analyses except where specifically identified and explained (i.e., for certain tests of assumptions).

Data screening. Preliminary data screening was conducted as follows:

1. Univariate descriptive statistics were checked for accuracy of input. Means and standard deviations were checked for plausibility and discrete variables were checked for any out-of-range values.
2. The amount and distribution of missing data were evaluated. In the case of missing data the following actions were considered: (a) deleting cases, (b) estimating missing data, (c) using a missing data correlation matrix, (d) treating missing data as data, and (e) repeating analyses with and without missing data.
3. Extreme univariate outliers were identified using a boxplot. Cases with values that were more than three box-lengths from the upper (75th percentile) or lower (25th percentile) edges of the box (50% of cases have values within the box) were identified as extreme outliers (Norusis, 1994).

The identification of extreme univariate outliers resulted in the following verification actions: (a) cases were checked to verify that data were correctly entered, (b) cases were verified to be members of the target population, and (c) $\underline{z}$ scores were computed to verify the extreme nature of the scores. Possible actions consisted of: (a) correcting errors in data entry, (b) deleting the case, and (c) retaining the case with altered data.

4. All variables used in parametric tests of significance were checked for univariate normality. Although many parametric tests are robust to violations of the assumption of normality, solutions are usually better if the variables used in such tests are normally distributed (Tabachnick & Fidell, 1989). Normal probability plots provided a visual basis for checking normality and the Lilliefors (Kolmogorov-Smirnov) test provided a statistical method of checking for normality. Conventional but conservative (.001) alpha levels were used to evaluate the hypothesis that the distribution for each variable is not normal (Tabachnick & Fidell, 1989).

5. Finally, variables were evaluated for multicollinearity (very highly correlated variables) and singularity (perfectly correlated variables). A correlation matrix was used for this purpose. Tabachnick and Fidell (1989) use the rule of thumb that the correlation must be stronger than -.70 or +.70 to be a serious problem. Multicollinearity creates both logical and

statistical problems. Logically, the dilemma is whether or not to include redundant variables in the same analysis. Redundant variables are not needed and they weaken the analysis because they reduce degrees of freedom for error. Statistically, multicollinearity creates problems at very high correlations where it produces unstability in calculations involving matrix inversion.

Data screening analyses were conducted prior to addressing any research question so that decisions on how to deal with the data (e.g., transformation of variables or deletion of cases) were not influenced by how these decisions might influence research findings. Chapter IV contains the results of data screening.

It was not statistically sound to screen for multivariate outliers as part of preliminary data screening because all variables were not used in every analysis. Instead, data were screened for multivariate outliers as an early step in analyzing data for each research question, where an analysis using the criterion of $p < .001$ for Mahalanobis distance (Norusis, 1994) was performed on the appropriate variables.

Supporting analyses. On occasion, inferential statistics were used for supporting analyses (e.g., to determine whether dropouts and nondropouts differed significantly on certain demographic and outcome variables). Levene's test (Glass &

Hopkins, 1996; Norusis, 1994) was used to check the assumption of homogeneity of variance as appropriate. If the number of subjects differed significantly between groups, the Bartlett-Box $F$ test was used instead of Levene's test as recommended by Glass and Hopkins (1996). When the means of two groups were compared on interval scale variables, the independent samples $t$ test was used if the assumption of homogeneity of variance was tenable and the Mann-Whitney $U$ test was used if the assumption was not tenable. The paired $t$ test was used when a single group was measured twice, once before and once after a common experience. If there were more than two groups involved, a one-way analysis of variance (ANOVA) was used and, when the main effect was significant, the Dunn (Bonferroni) test was also used for post hoc analysis (Norusis, 1994). Finally, the independent proportions $\chi^2$ test was used to compare the means of two groups on nominal scale variables.

Research Question Number 1

What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?

Four repeated measures ANOVAs were performed to analyze the data for research question number 1.

The independent variable for each ANOVA was observation (three levels: pretest observation, posttest observation, and delayed test observation). Each ANOVA used a different dependent variable. These variables were: (a) computer anxiety, (b) computer confidence, (c) computer usefulness, and (d) computer liking. These ANOVAs provided evidence pertaining to whether or not the means of the three observations for each dependent variable differed significantly.

Multiple univariate analyses were conducted, versus a single multivariate analysis, because: (a) the research question sought to determine patterns of stability and change for each dependent variable, (b) the dependent variables were conceptually independent, and (c) repeated measures ANOVAs have greater statistical power than a MANOVA (except when the sphericity assumption is seriously violated).

Two general strategies were available for analyzing a one-factor repeated measures design: the multivariate approach and the univariate mixed-model approach (Zwick, 1993). The univariate mixed-model approach was used in this study because it is more powerful than the multivariate approach, although it requires the additional assumption of sphericity. Using the univariate mixed-model approach, the analysis was treated as a Subjects x Observation ANOVA. The appropriate $\underline{F}$ ratio is the mean square for Subjects divided

by the mean square for the Subjects x Observation interaction.

The following repeated measures ANOVA assumptions were made: (a) all dependent variables were interval-level variables; (b) there were no extreme within-cell outliers; (c) residuals were normally distributed; (d) the variance-covariance matrix of the transformed variables used to test the effect has covariances of 0 and equal variances (symmetry); (e) the covariance matrix of the transformed variables had a constant variance on the diagonal and zeros off the diagonal (sphericity); (f) observations between subjects were independent (i.e., one subject's responses to the questionnaires had no effect on any other subject's responses); and (g) missing data were missing on a random basis, unrelated to any characteristic that would render the sample nonrepresentative.

The data were analyzed for extreme univariate outliers during data screening using the boxplot (cases with values that were more than 3 box-lengths from the upper or lower edges of the box).

The assumption of normality of the distribution of residuals was checked using residuals scatterplots.

Mauchly's test of sphericity was used to test the sphericity assumption (Norusis, 1994).

Cases with missing data (i.e., dropouts) were discarded. In these cases independent samples _t_ tests were conducted to compare the means of dropouts with the means of those who completed the study on pretest observation variables in order to determine if significant differences existed between the two groups.

Glass and Hopkins (1996) state that the method-of-choice for the analysis of repeated measures ANOVA is to use the _p_-values yielded by the Huynh-Feldt adjustment where departures from the sphericity assumption are encountered. The Huynh-Feldt method was used in this study. It involved computing epsilon ($\varepsilon$), which is the amount of departure from the sphericity assumption. When sphericity was violated, the value of $\varepsilon$ was used to compensate for this condition by adjusting the related degrees of freedom for effects that involved the repeated measures independent variable. Without this adjustment, the probability of a Type I error would be greater than claimed.

Since the levels of the repeated measures factor were ordered along a time-line, trend analysis using orthogonal polynomial contrasts was also conducted in order to obtain contrasts of the means. Glass and Hopkins (1996) recommend this procedure as more informative than multiple comparisons when a continuum underlies the repeated measures factor. Trend analysis allows one to assess whether the relationship

between the independent variable and each dependent variable is linear or has a nonlinear pattern. If nonlinear, trend analysis identifies the general shape of the best fitting trend line of each dependent variable. Specifically, trend analysis addresses two independent questions for the three means of each dependent variable:

1. Is there a linear trend among the three means, that is, can a linear regression line predict the cell means significantly better than the grand mean?
2. Is there a quadratic component among the three means that can account for a significant amount of the variance in each cell mean over and above that provided by the grand mean and the linear contrast?

Trend analysis used the same assumptions as the repeated measures ANOVA with one exception. No assumption of sphericity was necessary for the trend analysis.

Research Question Number 2

Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the end of a computer literacy course and what optimum weight should be associated with each predictor?

Multiple regression was used to find the dimensions along which computer anxiety can be explained and best predicted on the basis of computer confidence, computer

experience, computer knowledge, computer liking, computer usefulness, locus of control, and trait anxiety.

The following multiple regression assumptions were made: (a) all predictor and criterion variables were interval-level variables and were measured without error; (b) all predictor variables had a nonzero variance (i.e., each predictor variable had some variation in value); (c) there was no extreme multicollinearity or singularity; (d) the mean value of residuals was zero; (e) each predictor variable was independent of the residuals; (f) the variance of the residuals about the predicted scores was the same for all predicted scores (homoscedasticity); (g) the errors of prediction were independent of one another (i.e., there was an absence of autocorrelation or serial correlation); (h) there were no extreme outliers; (i) residuals had a linear relationship with predicted scores; and (j) residuals were normally distributed.

As a set, the first seven assumptions (a through g) are known as the Gauss-Markov assumptions (Berry, 1993). If met, least squares estimators have several desirable properties (e.g., unbiasedness and efficiency) and can be used for statistical inference (e.g., to conduct tests of statistical significance or to calculate confidence intervals).

To check for multicollinearity, eigenvalues of the scaled, uncentered cross-product matrices were examined to

determine if the data matrices were ill-conditioned. If a matrix is ill-conditioned, small changes in the values of the criterion variable or predictor variables can lead to large changes in the solution.

Assumptions concerning the distribution, linearity, and homoscedasticity of residuals were checked using the residuals scatterplot.

The Durbin-Watson test for serial correlation of adjacent error terms was used to test the assumption of independence of residuals. The possible range of values for this statistic is from 0 to 4. If residuals were not correlated with each other the value of this statistic was close to 2 (Norusis, 1994).

The data were analyzed for extreme univariate outliers during data screening using the boxplot (cases with values that were more than 3 box-lengths from the upper or lower edges of the box). The data were checked for multivariate outliers using the criterion of $p < .001$ for Mahalanobis distance (Norusis, 1994).

The stepwise multiple regression model with backward deletion was used for the analysis (Norusis, 1994). Using this model, all predictor variables were entered into the regression analysis in the first step. Thereafter, the variables were removed one at a time based on removal

criteria. To be removed, a variable must have a probability of *F* of .05 or greater (Norusis, 1994).

The procedure started out with the calculation of the multiple correlation coefficient (*R*), the square of the multiple correlation coefficient ($R^2$), and the adjusted $R^2$ with all predictor variables entered into the regression analysis. The predictor variables were deleted from the regression equation one at a time, and the loss to $R^2$ due to the deletion of the predictor and the effect on the adjusted $R^2$ were studied. Thus each variable was treated as if it were entered last in the equation. Consequently it was possible to observe which variable added the least when entered last. When no further variables could be deleted based on the removal criteria, the analysis was terminated. This backward deletion procedure of removing variables helped protect against inclusion of multicollinear variables and resulted in a parsimonious solution.

The regression analysis also consisted of determining: (a) unstandardized (*B*) weights with confidence limits, (b) standardized ($\beta$) weights, and (c) the prediction equation.

The regression solution was also checked for the presence of one or more suppressor variables. A suppressor variable is identified if the absolute value of the simple correlation between a predictor variable and the criterion variable is substantially smaller than the beta weight for

the predictor variable, or if the simple correlation and β weight have opposite signs (Tabachnick & Fidell, 1989).

To ascertain how much shrinkage occurred in the multiple correlation when the regression equation was applied to a new sample, a cross-validation analysis was conducted. The regression equation developed using fall 1995 semester subjects was used to predict the posttest computer anxiety scores for each subject in the spring 1996 sample based on their pretest observation scores.

The following procedures, as recommended by Pedhazur (1982), were used to conduct the cross-validation analysis:

1. A regression equation and $R^2$ were calculated using the fall 1996 semester sample (screening sample).

2. The regression equation was applied to the predictor variables of the spring 1996 semester sample (calibration sample).

3. Pearson $r$ (analogous to the multiple correlation coefficient $R$) was calculated between the observed criterion scores and the predicted scores of the spring 1996 semester sample.

4. The difference between $R^2$ of the fall 1995 semester sample and the $R^2$ of the spring 1996 semester sample was calculated (an estimate the amount of shrinkage).

5. If the shrinkage were small and the $R^2$ were meaningful, the screening and calibration samples were combined and a new

regression equation was developed for use in future predictions.

Research Question Number 3

How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and course instructor?

The quasi-experimental design used for this research question provided controls of when and to whom the measurements were made, but because intact classes were used, the equivalence of the two treatment groups was not assured. Consequently analysis of covariance (ANCOVA) was used to analyze the data because: (a) it adjusts preexisting differences between the intact groups, and (b) it increases the precision of the analysis by reducing the error variance.

Four 2 x 2 (Treatment Type x Course Instructor) ANCOVAs were conducted, each using one of the following dependent variables measured at the posttest observation: (a) computer anxiety, (b) computer confidence, (c) computer liking, and (d) computer usefulness. The covariate for each analysis was the applicable dependent variable measured at the pretest observation.

Since the cells in this design were of unequal size, the SPSS general factorial ANCOVA model for unbalanced univariate designs was used (Norusis, 1994).

Multiple univariate analyses were conducted (versus a single multivariate analysis) because: (a) the research question sought to identify differences in each dependent variable, and (b) the dependent variables were conceptually independent.

The following ANCOVA assumptions were made: (a) all dependent variables were interval-level variables; (b) there were no extreme within-cell outliers; (c) the sampling distributions of means were normal within each group; (d) the variance of dependent variable scores within each cell of the design was a separate estimate of the same population variance (homogeneity of variance); (e) the slope of the regression of the dependent variable on the covariate within each cell was an estimate of the same population regression coefficient, that is, that the slopes were equal for all cells (homogeneity of regression); (f) the relationship between each covariate and its related dependent variable was linear; (g) there was no extreme multicollinearity; and (h) the covariates were measured without error.

The boxplot for each cell was checked to identify extreme within-cell outliers (cases with values that were more than 3 box-lengths from the upper or lower edges of the box).

Residuals plots were checked to determine if assumptions of normality were violated.

The Bartlett-Box F test was used to test homogeneity of variance. The null hypothesis for this test was that all population cell variances were equal.

Homogeneity of regression was tested by determining if there was a significant interaction between each independent variable and covariate using analysis of variance procedures. The null hypothesis for this test was that the slope was the same across all levels of each independent variable.

Each covariate and its related dependent variable were checked by means of bivariate plots to determine if their relationships were linear. A linear relationship between variables was required since the ANCOVA model adjusted the dependent variables based on the covariate using a linear regression model.

Additionally, since Glass and Hopkins (1996) state that the credibility of ANCOVA findings is reduced when the amount of extrapolation is large, a check was also made to determine whether or not the adjusted and unadjusted means differed considerably.

Cases with missing data (i.e., dropouts) were discarded. In these cases independent samples t tests were conducted to compare the means of dropouts with the means nondropouts on pretest observation variables in order to determine if significant differences existed between the two groups.

Since self-report instruments were used to measure the covariates, there are no assurances that the covariates were measured without error. An assumption of this study is that subjects responded honestly to the questions on the self-report questionnaires.

As there were only two levels for each independent variable, no post hoc analyses were necessary to determine which pairs of group means were significantly different from each other.

## Threats to Validity

### Introduction

The factors that jeopardized the internal validity of this study, to varying degrees, were: (a) compensatory equalization of treatments, (b) contemporary history, (c) diffusion or imitation of treatments, (d) experimental mortality, (e) instrumentation, (f) selection, (g) statistical regression, and (h) testing.

The threats to external validity were: (a) interaction effects of selection biases and the treatment, (b) reactive effects of experimental arrangements, (c) researcher effects, and (d) treatment implementation.

The following paragraphs describe each of these threats to the validity of this study and the actions taken to control or minimize their effects.

Compensatory Equalization of Treatments

The compensatory equalization of treatments threat consisted of the possible compensation by instructors in one treatment if they considered the other treatment more desirable. Only research question number 3 was susceptible to this threat because it involved two different treatments.

Actions to control for compensatory equalization of treatments consisted of: (a) instructor training that addressed this issue; (b) use of instructor journals for each treatment (see Appendixes C and D); (c) random and unannounced implementation checks of over 25% of each treatment using a direct observation protocol; and (d) weekly comparisons of instructor journal entries, observer reports, treatment plans, and treatment syllabi by the researcher to provide feedback to the instructors in order to help maintain treatment fidelity.

Contemporary History

The contemporary history threat involved the influence on the dependent variables of events that may occur between dependent variable measurements. Such events could have stimulating or depressing effects upon the performance of subjects during testing. Generally, the longer the time span between measurements, the greater the probability that something can happen in the subjects' environment to affect the results.

Research questions number 1 and number 3 were particularly susceptible to the threat of contemporary history. Research question number 1 was susceptible because the time-series design spanned a relatively long period of time. The comparison group design used for research question number 3 was susceptible because contemporary history could affect one treatment group but not the other. Validity becomes an issue of plausible competing hypotheses that offer possible alternative explanations of shifts in the time-series or differences between groups other than the effects of the treatments.

Actions to control for contemporary history included: (a) use of a relatively short time between observations (13 weeks), (b) use of the End-of-Study Questionnaire that elicited information from subjects concerning their involvement in events or activities that could confound the dependent variables (see Appendix H), and (c) rejecting subjects for participation in the study that were concurrently enrolled in other computer literacy courses.

<u>Diffusion or Imitation of Treatments</u>

The diffusion or imitation of treatments threat dealt with the potential decay of the differences between treatments over time as the result of subject interaction. Only research question number 3 was susceptible to this threat because it consisted of two treatments that were

taught in the same building during the spring 1996 semester. If subjects in one group came under stress during the course of the semester, they might have obtained help from their peers in the other treatment group, thus raising the threat of diffusion or imitation of treatments.

Actions to control for diffusion or imitation of treatments consisted of: (a) use of the End-of-Study Questionnaire to obtain information from subjects concerning the use of outside help, and (b) portrayal of both treatments as equally desirable.

Experimental Mortality

The experimental mortality threat involved subject dropouts and the possibility that dropouts differed in important ways from subjects who completed the study. Research question number 1 was particularly susceptible to subject mortality because it spanned 26 weeks and included a delayed test observation that was not conducted during time allotted for ECI 304 instruction. Consequently subjects were required to complete the delayed test questionnaires on their own time.

Actions to control for mortality included: (a) tracking each subject by name, address, and telephone number during the study in order to identify dropouts; (b) use of class time to complete all questionnaires, with the exception of the delayed test for research question number 1; (c)

verifying subject addresses during the research question number 1 posttest observation; (d) sending the delayed test materials for research question number 1 to each subject by mail under cover of a university letter of transmittal signed by a university department chair (see Appendix J); (e) sending a follow-up letter along with another copy of the delayed test questionnaires to subjects who did not respond to the initial mailing within 7 days; (f) conducting telephonic follow-ups as required; (g) paying each fall 1995 semester subject $5.00 at the completion of the delayed test observation; and (h) conducting a comparative analysis between dropouts and nondropouts using pertinent pretest observation data.

Instrumentation

The instrumentation threat involved changes in test calibration as the result of: (a) the inadequate control of a suitable stimulus to elicit computer anxiety during testing, (b) use of different testing procedures for each observation, and (c) differences between observers in the recording of data.

The theoretical framework for anxiety stipulates that a stimulus is required before state anxiety manifests itself. It was therefore necessary to control for this stimulus during all testing involving the measurement of computer anxiety. Without control there was a danger of differential

measurements of computer anxiety attributable to different stimuli. All research questions were susceptible to this threat.

The consistency of observers in recording data was an issue for research question number 3 only.

Actions to control for instrumentation included: (a) use of objective tests, (b) use of the same procedures for all observations (see Appendix A), (c) use of the pilot study to examine the effects of various computer stimuli on the computer anxiety scores of subjects, (d) observer training, and (e) monthly checks of interobserver agreement throughout the spring 1996 semester.

Interaction Effects of Selection Biases and the Treatment

This threat involved the characteristics of the subjects who were selected to participate in the study. Subject characteristics largely determine how extensively study findings can be generalized. The major threats to this study involved the use of volunteers and the absence of random selection, which are study limitations.

Actions to control the interaction effects of selection biases and the treatment included: (a) use of procedures to promote a high volunteer rate, (b) use of a comparative analysis between volunteers and nonvolunteers, and (c) use of intact classes from a required teacher education program course.

Reactive Effects of Experimental Arrangements

The reactive effects of experimental arrangements threat arises from the experimental setting which will not occur in nonexperimental settings. Examples are the presence of observers in the classroom during the spring 1996 semester and the use of specific start times for treatments. Campbell and Stanley (1963) state that intact classes are less reactive than taking random samples out of the classrooms and placing them in different treatment groups.

Actions to control for reactive effects of experimental arrangements included: (a) use of intact classes, (b) counterbalancing course start times by treatment types for research question number 3, and (c) minimal use of observers.

Researcher Effects

Researcher effects pertain to the influence on treatments by the researcher. It is possible that the researcher, who developed the humanistically-focused treatment plan, exerted undue (although not conscious) influence on the subjects in the humanistically-focused treatment to perform better on outcome variables than the subjects in the cognitively-focused treatment. Additionally, some individuals might view the instructional techniques as complex which can only be implemented by someone with the researcher's special knowledge and dedication.

Researcher effects were a potential threat to the validity of research question number 3 because the researcher taught two sections of ECI 304 during the spring 1996 semester.

Actions to control for researcher effects included: (a) use of two course instructors for research question number 3, with each instructor teaching one cognitively-focused treatment and one humanistically-focused treatment; and (b) use of course instructor as an independent variable in a factorial ANCOVA in order to test for evidence of researcher effects.

Selection

The selection threat involved possible biases resulting from the differential selection of subjects for the cognitively-focused treatment group and the humanistically-focused treatment group. This threat only pertained to research question number 3.

Actions to control for selection included: (a) random assignment of intact classes to each of the two treatment groups, and (b) use of the ANCOVA model for statistical analyses in order to help control for pretest differences among groups.

Statistical Regression

The statistical regression threat involved the tendency of groups chosen on the basis of extreme scores to score

closer to the group mean on subsequent measurements. Consequently the effect of statistical regression can be mistaken for the treatment effect.

Statistical regression was a potential threat to the internal validity of research question number 2 because the COMPAS was used to identify subjects who are resistant to reduction of computer anxiety. Such subjects are likely to have extreme COMPAS scores. However, Campbell and Stanley (1963) state that statistical regression is not a problem when groups selected for independent reasons turn out to have extreme scores. This criteria was met by this study because of the use of intact groups.

Testing

Testing was a threat because all test instruments were self-report questionnaires and some questionnaires were repeatedly administered to the same subjects. Subjects who are repeatedly measured using the same test instrument may remember previous responses and reply in the same manner, regardless of their current anxiety and attitudes. Additionally, the pretests can sensitize subjects to the dependent variables and influence subsequent measurements.

Only the CAS and COMPAS were administered repeatedly to each subject. Research question number 1 was particularly susceptible to this threat because it included three repeated measurements using these test instruments.

Actions to control for testing included: (a) use of a 13-week interval between measurements, and (b) randomized use of COMPAS parallel forms for measuring computer anxiety.

Treatment Implementation

The treatment implementation threat involved potential violation of treatment fidelity. This threat only applied to research question number 3 because two different treatments were used.

Actions to control for treatment implementation included: (a) use of a common instructional plan for each treatment (see Appendixes C and D) that incorporate specific goals, learning outcomes, and experiences that distinguish the two treatments; (b) use of a common syllabus for each treatment (see Appendixes E and F); (c) use of instructor training; (d) random and unannounced implementation checks of each treatment based on a direct observation protocol; and (e) establishment and maintenance of instructor journals by each instructor in order to provide additional documentation for each treatment and to help control teaching processes.

## Direct Observation Protocol

### Introduction

A direct observation protocol was implemented during the spring 1996 semester in order to establish and maintain experimental control over the teaching processes used for

research question number 3. Consequently the focus of the observations was the course instructor, not the subjects.

Description

The direct observation protocol included the following features:

1. An equal number of class meetings from both treatments were randomly checked by two graduate assistant independent observers throughout treatment duration.

2. The independent observers were reimbursed for their services.

3. Over 25% of all class meetings were checked.

4. The independent observers used a common form for all observations (see Appendix I).

5. The independent observers conducted simultaneous recording of observations to enhance accuracy.

6. The independent observers were trained by the researcher.

7. Interobserver agreement was checked monthly throughout the semester.

8. The researcher was the only interpreter of the observations.

9. The researcher initiated corrections, as needed, in the delivery of each treatment in order to maintain alignment of treatments with treatment plans (see Appendixes C and D) and treatment syllabi (see Appendixes E and F).

Observer Bias

Observer bias was controlled by: (a) observer training; (b) use of two independent observers; (c) monthly checks of interobserver agreement; (d) the collection of specific, factual data by the independent observers; and (e) the observers' lack of detailed knowledge concerning the purpose of the study.

Interobserver agreement was checked throughout the semester. Two class meetings (one cognitively-focused treatment and one humanistically-focused treatment) were randomly selected each month for the purpose of determining interobserver agreement. Both observers viewed each of these class meetings and independently completed their observation forms (see Appendix I). The procedures used to compute interobserver agreement were based on the exact agreement method described by Hittleman and Simon (1992). Agreements on both occurrence and nonoccurrence were divided by the total number of items. Items number 1 and number 2 on the observation form (date and time of class meeting and instructor's name) were not used to determine interobserver agreement because these items were completed prior to the observation. All other items on the form were used.

Observer Training

The independent observers were prepared by: (a) a training session conducted by the researcher that emphasized

objectivity and consistency, (b) a dry run of the observation procedures, (c) a critique of the results of the dry run, and (d) a critique of the results of the initial check of interobserver agreement.

# CHAPTER IV

# RESULTS

## Introduction

This study pursued answers to the following questions using quasi-experimental methodologies:

1. What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?
2. Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the end of a computer literacy course and what optimum weight should be associated with each predictor?
3. How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and course instructor?

Chapter IV contains the results of all statistical analyses including rationales for tests used, statistical characteristics of samples, tests of assumptions, and descriptions of the statistical significance of important and noteworthy results. Separate sections address the pilot study and the main study, with the main study section organized around the study's three research questions. Discussions and interpretations of results are contained in Chapter V.

An alpha level of .05 was used for all statistical tests, except where specified.

## Pilot Study

### Introduction

The pilot study used a sample drawn from the experimentally accessible population in order to: (a) improve test administration procedures and the locally developed instruments; (b) assess volunteer and mortality rates; (c) demonstrate the reliability of all scales used in the main study; (d) determine whether the presence of computers affected measurements of computer anxiety; (e) ascertain levels of computer anxiety and attitudes about computers; and (f) conduct preliminary testing of the research hypothesis for research question number 2.

The pilot study was conducted using volunteers enrolled in all three sections of ECI 304, Educational Applications of Technology, taught at Old Dominion University during the summer 1995 semester: (a) 8:00 a.m. to 9:20 a.m., five days per week, May 15 through June 23; (b) 9:30 a.m. to 10:50 a.m., five days per week, May 15 through June 23; and (c) 5:45 p.m. to 8:55 p.m., Tuesdays and Thursdays, May 9 through June 22. Two instructors taught the three sections (the same instructor taught the two morning sections). One instructor was a professor of Educational Curriculum and Instruction and

the other was an associate professor of Educational Curriculum and Instruction at Old Dominion University.

Data collection consisted of administration of the Start-of-Study Questionnaire and four published test instruments during the week of May 15, 1995 and administration of the End-of-Study Questionnaire and the same four published test instruments four weeks later, during the week of June 12 (see Table 2). The pretest observation was conducted at the end of the first week of the semester, and the posttest observation was conducted during the final week of class meetings, one week prior to the final course examinations.

Descriptive Results

The sample consisted of 47 volunteers. Thirty-three subjects (70.2%) were females and 14 subjects (29.8%) were males. The mean pretest computer anxiety score for females was 105.64 (SD = 34.80) and for males it was 89.93 (SD = 25.36). The mean age was 26.04 years (SD = 8.51) with a range of 18 to 56 years. Four subjects (8.5%) were sophomores, 13 subjects (27.7%) were juniors, 15 subjects (31.9%) were seniors, and 15 subjects (31.9%) were graduate students. No freshmen were enrolled. Twelve subjects (25.5%) expected to teach at an elementary school, 11 subjects (23.4%) expected to teach at a middle school, and 24 subjects (51.1%) expected to teach at a high school.

Thirty-two subjects (68.1%) reported that they owned a personal computer. The mean pretest computer anxiety score for subjects who owned computers was 91.78 (SD = 32.82) and for subjects who did not own computers it was 120.53 (SD = 32.12). The mean posttest computer anxiety score for computer owners was 84.63 (SD = 35.24) and for subjects who did not own computers it was 111.00 (SD = 32.12).

Based on a total possible score of 0 (no knowledge) to 33 (considerable knowledge) for the 11 computer knowledge areas listed in Table 4, subjects responded with a mean total score of 10.09, a standard deviation of 6.85, and a range of 0 to 25. The mean subject response to the typical number of hours per week during the school year they used a computer at school, at home, and at work was 4.48 hours, with a standard deviation of 6.97 hours and a range of 0 to 40 hours.

Volunteers and Dropouts

The volunteer rate was 85.5%. Forty-seven students volunteered to participate in the pilot study and eight students chose not to volunteer. Six nonvolunteers were enrolled in the 9:30 a.m. section, and two nonvolunteers were enrolled in the 5:45 p.m. section. The 9:30 a.m. section with the highest nonvolunteer rate was the only section in which the instructor was not present for the pretest observation.

Four students provided the following written reasons for not volunteering: "I do not like participating in long

surveys because I don't feel that I can be objective," "I don't want to volunteer," "I am not volunteering because I do not know enough about computers," and "I really don't feel well today and there are other errands I can take care of if there is no scheduled class today." The remaining four nonvolunteers elected not to divulge their reasons for not volunteering.

Only one nonvolunteer chose to leave the classroom. Four nonvolunteers completed the Start-of-Study Questionnaire anonymously. The remaining three nonvolunteers were observed by the researcher using either entertainment or word processing software during the time volunteers were completing the test battery.

Since the use of volunteers was considered a possible source of bias in this study, statistical tests were conducted to determine whether volunteers differed from nonvolunteers on variables measured by the Start-of-Study Questionnaire. Independent samples $t$ tests were used to compare volunteers ($n$ = 47) and nonvolunteers who completed the questionnaire ($n$ = 4) on the following interval scale variables: age, computer experience, and computer knowledge. Additionally, independent proportions $\chi^2$ tests were used to compare volunteers with nonvolunteers who completed the questionnaire on the following nominal scale variables: sex, class standing (i.e., sophomore, junior, senior, or

graduate), anticipated teaching level (i.e., elementary, middle school, and high school), and computer ownership.

Using the Bartlett-Box $F$ test, the degree of heterogeneity of variance between groups on each interval scale variable was found to be nonsignificant. The $t$ tests revealed no statistically significant differences between the means of volunteers and nonvolunteers on: age, $t(49) = 1.19$, $p = .24$; computer experience, $t(49) = .05$, $p = .96$; and computer knowledge, $t(49) = .45$, $p = .66$. Additionally, the independent proportions $\chi^2$ tests showed no significant differences between volunteers and nonvolunteers on: sex, $\chi^2(1, N = 51) = .70$, $p = .40$; class standing, $\chi^2(3, N = 51) = 3.44$, $p = .33$; anticipated teaching level, $\chi^2(2, N = 51) = 2.05$, $p = .36$; and computer ownership, $\chi^2(1, N = 51) = .08$, $p = .77$.

All subjects who completed the pretest questionnaires and were present at the posttest observation volunteered to complete the posttest questionnaires. However, 11 subjects were dropouts and were not present for the posttest observation. Consequently, the mortality rate for the pilot study was 23.40%. The mortality by section was: (a) 8:00 a.m. section, five subjects; (b) 9:30 a.m. section, four subjects; and (c) 5:45 p.m. section, two subjects. The highest mortality was from the two morning sections, the only

sections in which the instructor was not present for the posttests.

Since dropouts were also considered a possible source of bias in this study, statistical tests were conducted to determine whether dropouts ($n$ = 11) differed from nondropouts ($n$ = 36) on variables measured by the pretest observation test battery: age, anticipated teaching level, computer anxiety, class standing, computer confidence, computer experience, computer knowledge, computer liking, computer usefulness, computer ownership, locus of control, sex, and trait anxiety.

Levene's test showed that the data for the following interval scale variables violated the assumption of homogeneity of variance: age, $F(45) = 5.13$, $p = .03$; computer anxiety, $F(45) = 5.73$, $p = .02$; computer confidence, $F(45) = 7.03$, $p = .01$; and computer liking, $F(45) = 7.25$, $p = .01$. Consequently the Mann-Whitney $U$ test, a nonparametric equivalent to the independent samples $t$ test, was used to test the hypothesis that dropouts differed from nondropouts for each of these variables. The independent samples $t$ test was used to test the remaining interval scale variables for which homogeneity of variance was not rejected. Lastly, the independent proportions $\chi^2$ test was used to test the nominal scale variables.

All analyses showed that dropouts and nondropouts did not differ significantly on any of the measured variables. The results of the Mann-Whitney $U$ tests were: age, $U(11,36) = 131.50$, $p = .09$; computer anxiety, $U(11,36) = 179.50$, $p = .64$; computer confidence, $U(11,36) = 163.50$, $p = .39$; and computer liking, $U(11,36) = 147.00$, $p = .20$. The results of the independent samples $t$ tests were: computer experience, $t(45) = 1.05$, $p = .30$; computer knowledge, $t(45) = -.45$, $p = .66$; computer usefulness, $t(45) = .15$, $p = .88$; locus of control, $t(45) = -1.82$, $p = .07$; and trait anxiety, $t(45) = -.89$, $p = .38$. Finally, the results of the independent proportions $\chi^2$ tests were: anticipated teaching level, $\chi^2(2, N = 47) = 4.47$, $p = .11$; class standing, $\chi^2(3, N = 47) = 1.77$, $p = .62$; computer ownership, $\chi^2(1, N = 47) = .14$, $p = .71$; and sex, $\chi^2(1, N = 47) = .93$, $p = .34$.

Test Administration Procedures

No major problems were experienced with test administration procedures. The researcher oriented subjects using a prepared text (see Appendix A) in order to provide a uniform explanation of the study to all potential subjects. All test instruments were assembled in consolidated test batteries and administered to all volunteers by group during normally scheduled class sessions.

Students were interviewed collectively by group after they completed each test battery. They offered few comments

concerning vague or misleading instructions. They did recommend that the researcher emphasize that prior computer experience was not a prerequisite to study participation in order to eliminate possible misunderstandings.

The mean time for subjects to complete all the questionnaires that comprised the main study pretest observation (Start-of-Study Questionnaire, Rotter's I-E Control Scale, trait form of the STAI, CAS, and parallel form of the COMPAS) was 16.86 minutes, with a standard deviation of 4.70 and a range of 8.5 to 29 minutes.

The mean time for subjects to complete all the questionnaires that comprised the main study posttest observation for research questions number 1 and number 2 (CAS and parallel form of the COMPAS) was 5.92 minutes, with a standard deviation of 2.23 and a range of 3 to 11 minutes.

Finally, the mean time for subjects to complete all the questionnaires that comprised the delayed test observation for research question number 1 and the posttest for research question number 3 (CAS, parallel form of the COMPAS, and End-of-Study Questionnaire) was 9.11 minutes, with a standard deviation of 2.97 and a range of 4.5 to 17.5 minutes.

### Scale Reliability

Introduction. The reliabilities of all scales used in this study were checked. All calculations of the coefficient of internal consistency were made using the pilot study

pretest observation. The Cronbach alpha method was used to calculate this statistic, except as noted below. The coefficient of stability (test-retest reliability) was based on a four week delay (the time interval between the pilot study pretest observation and the pilot study posttest observation). The statistic was calculated by correlating pretest and posttest measurements for each scale using the Pearson $r$ method. However, coefficients of stability calculated for the CAS, COMPAS, Computer Experience Scale, and Computer Knowledge Scale should be interpreted with caution because the treatment probably influenced the posttest scores. Because of theoretical considerations, it is unlikely that the treatment affected locus of control or trait anxiety posttest scores.

Computer Anxiety Scale (COMPAS). The COMPAS (Oetting, 1983) was used to operationalize computer anxiety. Oetting reported a Cronbach alpha reliability of .96 ($N$ = 482) for the long form and .93 ($N$ = 482) for each of the two parallel forms.

In this pilot study, the coefficients of internal consistency ($N$ = 47), after deleting filler questions, were: (a) .92 for the long form, (b) .81 for parallel form A, and (c) .93 for parallel form B. The coefficients of stability ($N$ = 36) were: (a) .78 for the long form, (b) .74 for parallel form A, and (c) .74 for parallel form B.

Table 3 examines the equivalency of the COMPAS forms. This method of calculating reliability is useful whenever two or more parallel forms of a test are available, as with the COMPAS. Examining the equivalence of the COMPAS parallel forms was necessary during the pilot study because the COMPAS parallel forms were administered in lieu of the long form to subjects in the main study on a random basis at each observation.

Table 3 shows the mean score for each COMPAS form and the mean score divided by the number of items for the pretest and the posttest observations.

Table 3

Pilot Study Means and Average Score per Item of COMPAS Forms for Pretest and Posttest Observations

| | Pretest[a] | | Posttest[b] | |
|---|---|---|---|---|
| COMPAS form | M | M/# items | M | M/# items |
| Long form | 100.96 | 2.52 | 93.41 | 2.34 |
| Parallel form A | 51.30 | 2.57 | 46.94 | 2.35 |
| Parallel form B | 49.66 | 2.48 | 46.47 | 2.32 |

Note. [a]N = 47. [b]N = 36.

Computer Attitude Scale (CAS). The CAS (Gressard & Loyd, 1985) measured the degree to which subjects: (a) have confidence in their abilities to use computers, (b) view computers as useful, and (c) like using computers. Loyd and

Loyd (1985) reported Cronbach alpha reliabilities of .89, .89, and .82 respectively for the scales of computer confidence, computer usefulness, and computer liking.

In this pilot study, the coefficients of internal consistency of the scales of computer confidence, computer usefulness, and computer liking ($N$ = 47) were .88, .83, and .84 respectively. The coefficients of stability ($N$ = 36) were .84,.83, and .87 respectively.

Computer Experience Scale. The Computer Experience Scale contained in the Start-of-Study Questionnaire consisted of two items that assessed subjects' experience with computers. The first item addressed typical computer usage in hours per week and the second item addressed the length of time of regular computer usage in years and months. Each of the two items addressed a different dimension of experience (i.e., typical computer use and length of time of regular computer use).

The split-half correlation method using the equal-length Spearman-Brown formula (one item in part 1 and one item in part 2) was used to obtain a coefficient of internal consistency of .68 for this scale. The coefficient of stability was .83.

Computer Knowledge Scale. The Computer Knowledge Scale contained in the Start-of-Study Questionnaire was used to operationalize computer knowledge. It sought information on

the subjects' depth of knowledge in 11 computer knowledge areas identified by Lockard, Abrams, and Many (1994).

In the pilot study, the scale mean was 10.09 and the standard deviation was 6.85. The coefficient of internal consistency was .90 ($N$ = 47) and the coefficient of stability was .77 ($N$ = 36).

Table 4 shows the relationship between the individual items of this scale and the composite score. The first column identifies the item or computer area. For each item, the second column shows the mean score for the scale if the item were deleted. The next column shows the scale variance if the item were deleted.

Another way to look at the relationship between an individual item and the rest of the scale is to predict a subject's score on that item based on the scores obtained on the other items. This was done by calculating a multiple regression equation with the item of interest as the criterion variable and the remaining items as predictor variables. The multiple $R^2$ from this regression equation is shown for each item in the column labeled $R^2$. Viewing this column, one can see, for example, that 72% of the observed variability in the response to the item assessing knowledge about database management can be explained by the other items. Finally, the last column displays the scale's Cronbach alpha reliability if that item were deleted from the scale.

Table 4

Computer Knowledge Scale Item-Total Summary Statistics

| Item/area | Scale M if item deleted | Scale variance if item deleted | $R^2$ | Cronbach Alpha if item deleted |
|---|---|---|---|---|
| Computer programming | 9.62 | 41.46 | .42 | .89 |
| Database management | 9.34 | 37.40 | .72 | .88 |
| Desktop presentations | 9.26 | 37.98 | .45 | .89 |
| Desktop publishing | 9.32 | 37.61 | .53 | .88 |
| Entertainment/games | 8.11 | 39.45 | .63 | .89 |
| Graphics programs | 9.28 | 36.47 | .61 | .88 |
| Multimedia/hypermedia | 9.57 | 40.29 | .50 | .89 |
| Networks | 9.68 | 39.92 | .67 | .88 |
| Spreadsheet programs | 9.30 | 38.30 | .69 | .89 |
| Telecommunications | 9.66 | 41.79 | .45 | .89 |
| Word processing | 7.72 | 39.73 | .62 | .89 |

Note. N = 47.

Rotter's I-E Control Scale. Rotter's I-E Control Scale (Rotter, 1966) was used to determine locus of control orientation. The reliability of this scale was of particular interest because of the length of time that elapsed since reliabilities were originally computed for this scale. Rotter (1966) and Anderson (1977) reported coefficients of internal

consistency of .70 and .76 respectively. Additionally, Rotter (1966) reported a coefficient of stability of .72.

In this pilot study, the coefficient of internal consistency was .73 (N = 47). The split-half correlation method and the unequal-length Spearman-Brown formula (12 items in part 1 and 11 items in part 2) were used after deleting the six filler items. The split-half correlation method was chosen over the Cronbach alpha method because Cronbach alpha is not appropriate for determining reliability of scales, such as Rotter's I-E Control Scale, in which items are answered dichotomously. The coefficient of stability was .74 (N = 36).

Trait Form of the STAI. The trait form of the STAI (Spielberger, 1983) assessed how subjects generally feel (versus how they feel at the time of the test). Spielberger (1983) reported Cronbach alpha internal consistency reliabilities of .90 for male (N = 324) and .91 for female (N = 531) college students. Additionally, he reported coefficients of stability of .73 for male and .77 for female college students over a six month period.

In this pilot study, the coefficient of internal consistency was .87 (N = 47) using a sample consisting of both males and females. The coefficient of stability was .76 (N = 36).

Stimuli for Computer Anxiety

Gaudry and Spielberger (1971) described state anxiety as a reaction to a specific stimulus at a point in time. An objective of the pilot study was to ascertain the stimuli necessary for computer anxiety to manifest itself in subjects prone to computer anxiety.

An experiment was performed to determine if there were significant differences in computer anxiety among subjects who: (a) completed the standard written form of the COMPAS without computers present, (b) completed the standard written form of the COMPAS with computers present, and (c) used a computer to complete the COMPAS. Subjects in the three sections of ECI 304 ($N$ = 47) were randomly divided, based on flips of coins, among the three computer anxiety stimuli conditions for the pretest observation of the COMPAS. Group number 1 ($n$ = 18) was administered the written form of the COMPAS in a classroom without computers present, group number 2 ($n$ = 15) was administered the same form of the COMPAS in a classroom with a computer at each subject location, and group number 3 ($n$ = 14) was administered a computer-based form of the COMPAS on a word processing file.

The null hypothesis tested was that subjects would manifest similar levels of computer anxiety regardless of the computer anxiety stimuli used. The independent variable was computer anxiety stimulus (three levels: computers absent,

computers present, and computers used). The dependent variable was computer anxiety as measured by the COMPAS pretest.

A one-way ANOVA was conducted to analyze the data using the general linear model for unbalanced designs because of the unequal group sizes. The Bartlett-Box $F$ test confirmed homogeneity of variance across groups. Table 5 provides a summary of the data analysis.

Table 5

Pilot Study Analysis of Variance for Computer Anxiety Stimulus

| Source | df | F |
|---|---|---|
| Computer anxiety stimulus | 2 | .94 |
| Error | 44 | (1079.59) |

Note. The value within the parentheses is the mean square error.

The F ratio was nonsignificant, $p = .40$. Consequently there was insufficient evidence to reject the null hypothesis that subjects would manifest similar levels of computer anxiety regardless of the computer anxiety stimuli used.

## Outcome Variables

The COMPAS was used to measure computer anxiety in all subjects as part of the pretest and the posttest observations. Possible scores ranged from a low of 40 to a

high of 200. Oetting (1983) identified five levels that can be used to interpret COMPAS scores, ranging from very relaxed to very anxious. He also provided normative data from a 1983 study that examined the computer anxiety levels of college freshmen (N = 482).

Table 6 provides percentile scores by level for both the pilot study (pretest and posttest) and Oetting's normative study based on the COMPAS long form.

Table 6

Levels of Computer Anxiety by Raw Scores, Pilot Study Pretest and Posttest Percentiles, and Normative Study Percentiles

| Level | Raw score | Pretest[a] P | Posttest[b] P | Normative[c] P |
|---|---|---|---|---|
| Very anxious | 160 | 95.7 | 94.4 | 97.9 |
| Anxious/tense | 140 | 87.2 | 83.3 | 93.6 |
| Mild anxiety present | 120 | 72.3 | 77.8 | 83.2 |
| Generally relaxed | 90 | 44.7 | 61.1 | 46.9 |
| Very relaxed | 70 | 17.0 | 27.8 | 23.2 |

Note. Percentiles reflect the percentage of subjects at or below the specified level.

[a]N = 47. [b]N = 36. [c]N = 482.

To test the hypothesis that there were significant differences between pretest and posttest scores on computer anxiety, computer confidence, computer liking, and computer

usefulness, four paired _t_ tests were conducted. Paired _t_ tests were used because the two samples were related and the degree of heterogeneity of variance between samples was found to be nonsignificant for each variable using Levene's test. The independent variable was test condition (two levels: pretest and posttest). The dependent variables for each _t_ test were, in turn, computer anxiety, computer confidence, computer liking, and computer usefulness.

Table 7 displays the means and standard deviations for pretest and posttest measurements of dependent variables and the results of the paired _t_ tests.

Table 7

_Pilot Study Tests of Significance Between Pretest and Posttest Means of Dependent Variables_

| | Pretest | | Posttest | | |
|---|---|---|---|---|---|
| Variable | _M_ | _SD_ | _M_ | _SD_ | _t_ |
| Computer anxiety | 100.86 | 36.14 | 93.42 | 35.00 | 1.90 |
| Computer confidence | 31.72 | 6.50 | 32.19 | 6.30 | -.79 |
| Computer liking | 30.78 | 5.77 | 30.86 | 7.13 | -.14 |
| Computer usefulness | 36.64 | 3.88 | 36.50 | 3.48 | .38 |

_Note._ _t_ ratios are nonsignificant.

_N_ = 36.

The results of the paired t tests showed no statistically significant differences between pretest and posttest means. Consequently the statistical tests provided insufficient evidence to reject the null hypothesis that there were no differences between pretest and posttest scores for each of the variables tested.

Preliminary Testing of Hypothesis

One of the objectives of the pilot study was to conduct preliminary testing of the research hypothesis for research question number 2. This research question sought to identify the variables that were the best predictors of the computer anxiety of urban teacher education students at the end of a computer literacy course. To answer this question, a multiple regression analysis was conducted using computer anxiety measured at the posttest observation as the criterion variable, and computer confidence, computer experience, computer knowledge, computer liking, computer usefulness, locus of control, and trait anxiety as the predictor variables.

Data screening revealed: (a) means and standard deviations of all variables were plausible, (b) no out-of-range values were identified, and (c) no data were missing. Boxplots for each variable confirmed that there were no extreme outliers (cases over three box-lengths from the upper or lower edge of the box). Finally, a visual inspection of

residuals scatterplots provided evidence of normality, linearity, and homoscedasticity between predicted scores and errors of prediction.

One of the first steps in calculating a regression equation is to calculate a correlation matrix. Table 8 shows such a correlation matrix between the criterion variable (computer anxiety) and each predictor variable.

Table 8

Pilot Study Correlation Matrix for Criterion and Predictor Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Computer anxiety[a] | -- | -.88 | -.42 | -.42 | -.86 | -.48 | .02 | .13 |
| 2. Computer confidence[b] | | -- | .41 | .38 | .82 | .47 | -.09 | -.10 |
| 3. Computer experience[b] | | | -- | .44 | .38 | .40 | .13 | .04 |
| 4. Computer knowledge[b] | | | | -- | .40 | .18 | .02 | -.29 |
| 5. Computer liking[b] | | | | | -- | .51 | -.01 | -.17 |
| 6. Computer usefulness[b] | | | | | | -- | .08 | .00 |
| 7. Locus of control[b] | | | | | | | -- | .43 |
| 8. Trait anxiety[b] | | | | | | | | -- |

Note. [a]Criterion variable. [b]Predictor variables.

$N$ = 36.

A stepwise multiple regression using backward deletion was performed between posttest computer anxiety as the criterion variable and each of the predictor variables. The

deletion criteria used was .05 as the maximum probability of F-to-remove. At Step 1 all variables were entered into the regression equation. At Step 2 computer usefulness, the variable with the smallest partial correlation coefficient at Step 1, was removed because the probability of its $t$, $p$ = .92, was greater than the removal criterion of .05. At Step 3 trait anxiety, the variable with the smallest partial correlation coefficient at Step 2, was removed because the probability of its $t$, $p$ = .89, was greater than the removal criterion. At Step 4 locus of control, the variable with the smallest partial correlation coefficient at Step 3, was removed because the probability of its $t$, $p$ = .75, was greater than the removal criterion. At Step 5 computer experience, the variable with the smallest partial correlation coefficient at Step 4, was removed because the probability of its $t$, $p$ = .66, was greater than the removal criterion. Finally, at Step 6 computer knowledge, the variable with the smallest partial correlation coefficient at Step 5, was removed because the probability of its $t$, $p$ = .47, was greater than the removal criterion. At Step 6 none of the remaining predictors met the removal criterion of .05, so the backward deletion stopped at this point.

Table 9 displays the unstandardized regression coefficients ($B$), the standard errors of the predicted values ($SE$ $B$), the standardized regression coefficients ($\beta$), and the

t ratios for Step 1 and Step 6 (the first and last steps of the regression analysis).

Table 9

Pilot Study Summary of Stepwise Regression Analysis for Variables Predicting Posttest Computer Anxiety

| Variable | B | SE B | β | t |
|---|---|---|---|---|
| Step 1 | | | | |
| Computer confidence | -2.95 | .76 | -.52 | -3.88* |
| Computer experience | -.16 | .47 | -.03 | -.34 |
| Computer knowledge | -.19 | .42 | -.04 | -.45 |
| Computer liking | -1.94 | .68 | -.39 | -2.86** |
| Computer usefulness | -.09 | .92 | -.01 | -.10 |
| Locus of control | -.25 | .75 | -.03 | -.33 |
| Trait anxiety | .05 | .41 | .01 | .13 |
| Step 6 | | | | |
| Computer confidence | -3.00 | .68 | -.54 | -4.43* |
| Computer liking | -2.07 | .60 | -.42 | -3.48** |

Note. $R = .92$ and $R^2 = .84$ for Step 1 through Step 6.

$N = 36$.

*$p < .001$. **$p < .01$.

Since the sample $R^2$ in any multiple regression tends to be an optimistic estimate of how well the model fits the population, an adjusted $R^2$ was calculated to more closely reflect the goodness of fit of the model to the population

(Norusis, 1994). For Step 1 the adjusted $R^2$ was .80, for Step 2 the adjusted $R^2$ was .81, for Step 3 and Step 4 the adjusted $R^2$ was .82, and for Step 5 and Step 6 the adjusted $R^2$ was .83.

The standard error of the estimate was 14.52 at Step 6. Thus one would expect the observed value of posttest computer anxiety to fall inside plus or minus 14.52 of the predicted value of posttest computer anxiety 68% of the time.

At Step 6, -4.38 to -1.62 was the 95% confidence interval for the computer confidence B coefficient and -3.28 to -.86 was the 95% confidence interval for the computer liking B coefficient.

The multiple regression analysis using the least squares solution yielded the following equation:

$$y' = 254.07 - 3.00x_1 - 2.07x_2$$

where y' is the predicted posttest computer anxiety score, $x_1$ is the computer confidence score, and $x_2$ is the computer liking score.

The null hypothesis that the multiple regression in the population is zero was tested using an ANOVA. Table 10 provides a summary of this analysis. It displays the source of variability (i.e., the observed variability that is attributable to the regression (labeled Regression) and the observed variability that is not attributable to the

regression (labeled Error)), degrees of freedom, and the F ratio.

Table 10

Pilot Study Analysis of Variance for the Multiple Linear Regression Model

| Source | df | F |
|---|---|---|
| Regression | 2 | 85.10* |
| Error | 33 | (210.89) |

Note. The value enclosed in the parentheses is the mean square error.

N = 36.

*p < .0001.

Since Table 10 shows that the regression solution was highly significant, the null hypothesis was rejected. Hence there was a significant relationship between the predictor variables, computer confidence and computer liking, and the criterion variable, posttest computer anxiety, and the observed relationship was not simply an unlikely chance occurrence.

## Main Study

### Introduction

The purpose of this study was to: (a) determine how a university computer literacy course affects the computer anxiety and computer attitudes of urban teacher education

students over time; (b) predict urban teacher education students who are resistant to reduction of computer anxiety; and (c) determine whether a humanistically-focused computer literacy course, that incorporates both cognitive and affective learning outcomes, is more effective than a cognitively-focused course in reducing computer anxiety and improving computer attitudes.

The study was conducted using volunteers enrolled in ECI 304, Educational Applications of Technology, at Old Dominion University during the 1995-96 academic year. Volunteers from all six sections of ECI 304 conducted during the fall 1995 semester (August 28 through December 8, 1995) were used as subjects for research questions number 1 and number 2. These sections met as follows: (a) 9:00 a.m. to 9:50 a.m. on Mondays, Wednesdays, and Fridays; (b) 10:00 a.m. to 10:50 a.m. on Mondays, Wednesdays, and Fridays; (c) 11:00 a.m. to 11:50 a.m. on Mondays, Wednesdays, and Fridays; (d) 11:00 a.m. to 12:15 p.m. on Tuesdays and Thursdays; (e) 1:30 p.m. to 2:45 p.m. on Tuesdays and Thursdays; and (f) 4:20 p.m. to 7:00 p.m. on Thursdays. Four instructors taught these six sections. Instructor number 1 taught the sections that met on Mondays, Wednesdays, and Fridays; instructor number 2 taught the section that started class meetings at 11:00 a.m. on Tuesdays and Thursdays; instructor number 3 taught the section that started class at 1:30 p.m. on Tuesdays and

Thursdays; and instructor number 4 taught the section that met at 4:20 p.m. on Thursdays. Instructors number 1 and number 4 were adjunct faculty members and instructors number 2 and number 3 were full-time university faculty members.

Volunteers from four sections of ECI 304 conducted during the spring 1996 semester (January 8 through April 23, 1996) were used as subjects for research question number 3. These sections met as follows: (a) 10:00 a.m. to 10:50 a.m., Mondays, Wednesdays, and Fridays (cognitively-focused treatment); (b) 11:00 a.m. to 11:50 a.m., Mondays, Wednesdays, and Fridays (humanistically-focused treatment); (c) 11:00 a.m. to 12:15 p.m., Tuesdays and Thursdays (cognitively-focused treatment); and 1:30 p.m. to 2:45 p.m., Tuesdays and Thursdays (humanistically-focused treatment). Two instructors were used. Instructor number 1 taught the two sections that met on Mondays, Wednesdays, and Fridays, and instructor number 2 taught the two sections that met on Tuesdays and Thursdays. Both instructors were adjunct faculty members. Instructor number 1 for the fall 1995 semester and instructor number 1 for the spring 1996 semester was the same person. Instructor number 2 for the spring 1996 semester did not teach during the fall 1995 semester.

Data collection consisted of administration of appropriate test instruments (see Table 2) as follows: (a) the pretest observation for research questions number 1 and

number 2 was conducted during the week of September 4, 1995, the second week of the semester; (b) the posttest observation for research questions number 1 and number 2 was conducted during the week of December 4, 1995, one week prior to semester final examinations; (c) the pretest observation for research question number 3 was conducted during the week of January 8, 1996, the first week of the spring 1996 semester; (d) the delayed test questionnaires for research question number 1 were mailed to subjects on March 2, 1996, with telephonic follow-up reminders on March 9 and 10; and (e) the posttest observation for research question number 3 was conducted during the week of April 15, 1996, one week prior to semester final examinations.

With the exception of the delayed test observation as noted above, all testing was conducted during class time by the researcher. Of the 86 sets of questionnaires that were mailed on March 2, 75 sets were returned by the March 15 deadline.

Fall 1995 Semester Volunteers and Dropouts

Introduction. The fall 1995 semester subject pool consisted of 113 students. However, 12 students were not eligible to participate in the study (seven students were concurrently enrolled in other computer literacy courses, one student expressed the intent of leaving the university at the end of the semester, one student was repeating ECI 304, and

three students were not enrolled in a teacher education program).

Volunteers. Of the 101 students who were eligible to participate in the study, 93 volunteered to participate resulting in a 92.1% volunteer rate. However, the researcher dropped one volunteer from the study because of an extremely negative computer usefulness attitude identified during pretest observation data screening, leaving 92 volunteers to start the study. Of the eight students who did not volunteer, four students wrote on their returned test battery that they were not interested in participating in the study, three students wrote that they did not have the free time to participate, and one student wrote that she did not believe in the merits of educational research. Since only one nonvolunteer completed the Start-of-Study Questionnaire, there was insufficient data to conduct a comparative analysis between volunteers and nonvolunteers.

Dropouts. Four subjects dropped out of the study as a result of their withdrawal from ECI 304 during the fall 1995 semester. An additional two subjects dropped out of the study at the end of the semester by not volunteering to complete the posttest questionnaires. Therefore, at the posttest observation the dropout or mortality rate was 6.52%. Additionally, 11 students dropped out of the study at the delayed test observation in March 1996 by failing to return

mailed questionnaires to the researcher by the March 15 deadline. Completed questionnaires were not accepted after March 15 in order to maintain equal 13 week time intervals between observations as required by the time-series analysis used for research question number 1. A total of 17 students were dropouts resulting in an overall dropout or mortality rate of 18.48% at the delayed test observation.

Since dropouts were considered a possible source of bias in this study statistical tests were conducted to determine whether dropouts ($n$ = 17) differed from nondropouts ($n$ = 75) on interval and nominal scale variables measured at the pretest observation.

Using the Bartlett-Box $F$ test of homogeneity of variance, the null hypothesis of equal variances was not rejected for any of the interval scale variables analyzed. Accordingly, independent samples $t$ tests were conducted to compare the means of dropouts and nondropouts on the interval scale variables measured at the pretest observation in order to determine if the differences were significant.

Table 11 provides the results of this comparison by listing the relevant degrees of freedom, means, standard deviations, and $t$ ratios. Table 11 shows that the independent samples $t$ tests revealed no significant differences between dropouts and nondropouts on any of the interval scale variables tested.

Table 11

Comparison of Fall 1995 Semester Dropouts and Nondropouts on Interval Scale Variables

| | | Dropouts[a] | | Nondropouts[b] | | |
|---|---|---|---|---|---|---|
| Variable | df | M | SD | M | SD | t |
| Age | 90 | 22.77 | 3.38 | 23.80 | 5.68 | -.72 |
| Computer anxiety | 90 | 52.59 | 13.82 | 53.69 | 15.48 | -.27 |
| Computer confidence | 90 | 31.00 | 5.51 | 31.27 | 5.83 | -.17 |
| Computer experience | 90 | 9.77 | 7.99 | 9.65 | 7.33 | .06 |
| Computer knowledge | 90 | 9.29 | 5.27 | 9.11 | 6.08 | .12 |
| Computer liking | 90 | 31.35 | 3.79 | 30.76 | 4.97 | .46 |
| Computer usefulness | 90 | 36.18 | 2.98 | 36.87 | 2.62 | -.96 |
| Locus of control | 90 | 11.71 | 4.07 | 10.67 | 4.10 | .95 |
| Trait anxiety | 90 | 38.24 | 8.08 | 38.48 | 9.86 | -.10 |

Note. t ratios are nonsignificant.

[a]n = 17. [b]n = 75.

Additionally, independent proportions $\chi^2$ tests were performed on the nominal scale variables. These tests showed no significant differences between dropouts and nondropouts on any of the three variables that were tested: sex, $\chi^2(1, N = 92) = 2.46$, $p = .12$; anticipated teaching level, $\chi^2(2, N = 92) = .21$, $p = .90$; and computer ownership, $\chi^2(1, N = 92) = .62$, $p = .43$.

Fall 1995 Semester Data Screening

Data collected on computer anxiety, computer confidence, computer usefulness, computer liking, computer experience, computer knowledge, locus of control, and trait anxiety were examined through various SPSS procedures for accuracy of data entry, missing values, extreme outliers, normality, and multicollinearity.

Means and standard deviations of all variables were plausible, no out-of-range values were identified, and no data were missing after the 17 dropouts were deleted from the study.

Interval scale variables measured at each observation were checked for extreme outliers. One subject manifested an extreme univariate outlier on the computer usefulness pretest observation. A boxplot revealed a score of more than three box-lengths below the lower (25th percentile) edge of the box. The $z$ score for this outlier was equal to -5.19. Additionally, this subject's scores on computer experience and computer liking were between 1.5 and 3 box-lengths below the lower edge of the box. Consequently this case was deleted from the group of volunteers because of the subject's extremely unfavorable attitude toward the usefulness of computers.

In order to help identify potential multicollinearity issues between variables, the correlation matrix in Table 12 contains variables measured at the pretest observation.

Table 12

Intercorrelations Between Pretest Variables from the Fall 1995 Semester Sample

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Computer anxiety | -- | -.77 | -.42 | -.63 | -.57 | -.26 | .17 | .35 |
| 2. Computer confidence | | -- | .34 | .48 | .72 | .48 | -.24 | -.30 |
| 3. Computer experience | | | -- | .59 | .19 | .17 | -.11 | -.05 |
| 4. Computer knowledge | | | | -- | .23 | .09 | .05 | -.01 |
| 5. Computer liking | | | | | -- | .58 | -.42 | -.39 |
| 6. Computer usefulness | | | | | | -- | -.33 | -.37 |
| 7. Locus of control | | | | | | | -- | .38 |
| 8. Trait anxiety | | | | | | | | -- |

Note. N = 92.

Table 12 reveals two pairs of variables that are highly correlated ($r > .70$): (a) computer confidence and computer anxiety have a correlation of -.77, and (b) computer confidence and computer liking have a correlation of .72.

Fall 1995 Semester Descriptive Results

Ninety-two volunteers were accepted as participants in the study at the beginning of the fall 1995 semester. Sixty-eight subjects (73.9%) were females and 24 subjects (26.1%)

were males. The average age was 23.61 years (SD = 5.33). Fifteen subjects (16.3%) were sophomores, 46 subjects (50%) were juniors, 24 subjects (26.1%) were seniors, and seven subjects (7.6%) were graduate students. Thirty-seven subjects (40.2%) planned to be elementary school teachers, 24 subjects (26.1%) planned to be middle school teachers, and 31 subjects (33.7%) planned to be high school teachers.

The mean pretest computer anxiety score for females was 53.53 (SD = 16.24) and for males it was 53.38 (SD = 11.69). The mean posttest computer anxiety score for females was 46.67 (SD = 11.10) and for males it was 47.32 (SD = 11.14).

Sixty-three subjects (68.5%) reported that they owned a personal computer. The mean pretest computer anxiety score for subjects who owned computers was 51.25 (SD = 14.15) and for subjects who did not own computers it was 58.35 (SD = 16.24). The mean posttest computer anxiety score for computer owners was 46.10 (SD = 10.55) and for subjects who did not own computers it was 48.36 (SD = 12.07).

Based on scale of 0 (no knowledge) to 33 (considerable knowledge) for the 11 computer knowledge areas listed in Table 1, subjects responded with a mean total score of 9.14 (SD = 5.91) with a range of 0 to 21.

Raw score means and standard deviations for each dependent variable measured during the pretest, posttest, and delayed test observations are provided in Table 13.

Table 13

Summary of Raw Scores for Fall 1995 Semester Subjects

| | Observation | | | | | |
|---|---|---|---|---|---|---|
| | Pretest[b] | | Posttest[c] | | Delayed test[d] | |
| Variable | M | SD | M | SD | M | SD |
| Computer anxiety | 53.49 | 15.12 | 46.84 | 11.05 | 43.88 | 9.96 |
| Computer confidence | 31.22 | 5.75 | 32.52 | 5.35 | 33.49 | 3.82 |
| Computer experience | 9.67 | 7.41 | 9.77 | 5.15 | -- | -- |
| Computer knowledge | 9.14 | 5.91 | 14.54 | 4.77 | -- | -- |
| Computer liking | 30.87 | 4.76 | 31.31 | 5.00 | 30.75 | 4.71 |
| Computer usefulness | 36.74 | 2.69 | 36.48 | 2.99 | 36.73 | 2.32 |
| Locus of control[a] | 10.86 | 4.09 | -- | -- | -- | -- |
| Trait anxiety[a] | 38.44 | 9.52 | -- | -- | -- | -- |

Note. [a]Variables measured at the pretest observation only.

[b]N = 92. [c]N = 86. [d]N = 75.

Table 14 provides percentile scores by level of computer anxiety, as defined by Oetting (1983), for the computer anxiety pretest observation and Oetting's normative study. Raw computer anxiety scores collected at the pretest observation were doubled for use in Table 14 in order to allow comparison with normative study scores. This was done because COMPAS parallel forms were used to score computer

anxiety in the main study and the normative study used scores yielded by the COMPAS long form. The COMPAS long form consists of both COMPAS parallel forms and the computer anxiety score is obtained by totaling the scores obtained from both parallel forms. This procedure was used because the pilot study confirmed that the COMPAS parallel forms were equivalent.

Table 14

Levels of Computer Anxiety by Raw Scores, Pretest Percentiles, and Normative Study Percentiles for the Fall 1995 Semester Sample

| Level | Raw score | Pretest[a] P | Normative[b] P |
|---|---|---|---|
| Very anxious | 160 | 96.7 | 97.9 |
| Anxious/tense | 140 | 81.5 | 93.6 |
| Mild anxiety present | 120 | 69.6 | 83.2 |
| Generally relaxed | 90 | 35.9 | 46.9 |
| Very relaxed | 70 | 9.8 | 23.2 |

Note. [a]N = 92. [b]N = 482.

The mean subject response (nondropouts) to the typical number of hours per week they used a computer at school, at home, and at work prior to the start of ECI 304 was 5.85 hours (SD = 8.52) with a range of 0 to 42 hours. Subject responses to this question for the 13 week period following

completion of ECI 304 was 8.70 hours (*SD* = 9.82) with a range of 0 to 45 hours. A paired *t* test showed that the difference between pretest and posttest computer usage means was significant, $t(74) = -3.92$, $p < .001$.

Subjects provided the following data at the delayed test observation: (a) 3 subjects (4%) received outside help, such as a tutor, during ECI 304; (b) 18 subjects (24%) purchased a computer since they started the study; (c) 57 subjects (76%) used a computer at work during the study; (d) 48 subjects (64%) used a computer for other courses during the study (all subjects described this use as incidental only, i.e., for the preparation of papers); and (e) 66 subjects (88%) stated that their expectations for ECI 304 were satisfied and 9 subjects (12%) stated their expectations were partly satisfied. The following additional responses were recorded by five subjects whose ECI 304 expectations were not entirely satisfied: "I wanted to learn more about WWW surfing and how to access (the Internet)," "I felt that more material pertaining to classroom uses could have been covered," "I thought the course was very basic," "I felt the class was primarily geared for general versus educational computer instruction," and "I had hoped and thought that the class would involve software applications that could be directly used in the classroom."

Using 5-point Likert scales, subjects also provided their ratings of the importance of computers to teachers and of their intention to use computers in the classroom at the delayed test observation. To the question "How important is it for teachers to use computer technology in the classroom to assist and/or manage instruction?" subjects responded with a mean rating of 4.43 (SD = .68) on a scale that ranged from 5 (extremely important) to 1 (not important). To the question "How would you presently describe your intention of using computer technology in the classroom to assist and/or manage instruction when you become a teacher, assuming the hardware and software you need are available?" subjects responded with a mean rating of 4.48 (SD = .58) on a scale that ranged from 5 (extremely likely to use computers) to 1 (not likely to use computers).

Research Question Number 1

Introduction. What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?

To help answer this question four repeated measures ANOVAs were conducted using, in turn, the following dependent variables: (a) computer anxiety, (b) computer confidence, (c) computer liking and (d) computer usefulness. These analyses provided evidence regarding whether or not the means of each

dependent variable differed significantly across the three observations. Using the univariate mixed-model approach, each analysis was treated as a Subjects x Observation ANOVA. This approach was used because it is more powerful than the multivariate approach, although it required the additional assumption of sphericity. When Mauchly's test of sphericity showed that the sphericity assumption was violated, the value of the Huynh-Feldt $\varepsilon$ was used to compensate for this condition by adjusting the related degrees of freedom for effects that involved the repeated measures independent variable. Without this adjustment, the probability of a Type I error would be greater than claimed.

Multiple univariate analyses were conducted, versus a single multivariate analysis, because: (a) the research question sought to determine patterns of stability and change for each dependent variable, (b) the dependent variables were conceptually independent, and (c) repeated measures ANOVAs generally have greater statistical power than a MANOVA.

Each ANOVA with a significant within subjects effect was followed by trend analysis using orthogonal polynomial contrasts. Trend analysis addressed two independent questions:

1. Is there a linear trend among the three means, that is, can a linear regression line predict the cell means significantly better than the grand mean?

2. Is there a quadratic component among the three means that can account for a significant amount of the variance in each cell mean over and above that provided by the grand mean and the linear contrast?

Posttest and/or delayed test observation data were missing for the 17 fall 1995 semester dropouts. Consequently dropouts were deleted from the data analyses resulting in a sample size of 75.

Table 15 displays the means and standard deviations of the dependent variables used in research question number 1 for each of the three observations.

Table 15

Means and Standard Deviations of Dependent Variables Used in Research Question Number 1

| | Observation | | | | | |
|---|---|---|---|---|---|---|
| | Pretest | | Posttest | | Delayed test | |
| Variable | M | SD | M | SD | M | SD |
| Computer anxiety | 53.69 | 15.48 | 46.79 | 11.19 | 43.88 | 9.96 |
| Computer confidence | 31.27 | 5.83 | 32.44 | 5.37 | 33.49 | 3.82 |
| Computer liking | 30.76 | 4.97 | 30.92 | 4.86 | 30.75 | 4.71 |
| Computer usefulness | 36.87 | 2.62 | 36.53 | 2.91 | 36.73 | 2.32 |

Note. N = 75.

Computer anxiety. Figure 1 depicts the trend line for computer anxiety means.

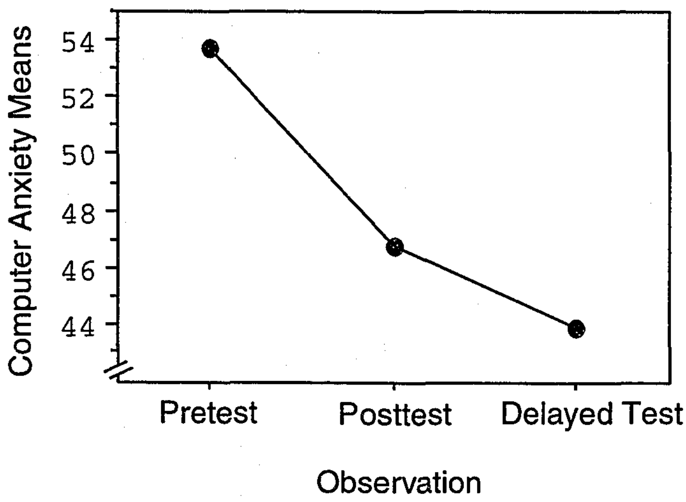


Figure 1. Trend line for computer anxiety means.

Figure 1 shows that subject computer anxiety levels were at their highest mean level at the pretest observation ($M$ = 53.69, $SD$ = 15.48), they were at their lowest mean level at the delayed test observation ($M$ = 43.88, $SD$ = 9.96), and they were between the pretest and delayed test mean levels at the posttest observation ($M$ = 46.79, $SD$ = 11.19). A repeated measures ANOVA was conducted to determine whether these observed differences were significant or can be attributable to chance.

The assumption of normality of the distribution of residuals was verified using the residuals scatterplot.

Mauchly's test of sphericity ($W$ = .75) provided evidence of departure from the assumption of sphericity, $\chi^2(2, N = 75)$

= 21.01, $p < .001$. Therefore, the within subjects degrees of freedom used were adjusted (Huynh-Feldt $\varepsilon = .81$).

Table 16 shows the results of the repeated measures ANOVA for computer anxiety. It contains the sources of variation, the degrees of freedom, and the *F* ratios.

Table 16

Repeated Measures Analysis of Variance for Computer Anxiety

| Source | *df* | *F* |
| --- | --- | --- |
| | Between subjects | |
| Constant | 1 | 1451.33* |
| Subjects (S) | 74 | (358.98) |
| | Within subjects | |
| Observations (O) | 1.63 | 36.32* |
| S x O | 120.60 | (52.47) |

*Note.* Values enclosed in parentheses are mean square errors. $N = 75$.

*$p < .001$.

The between subjects null hypothesis tested was that there were no differences in computer anxiety levels. Based on the data displayed in Table 16 the null hypothesis was rejected on the basis of the significant *F* ratio for the between subjects constant effect.

The within subjects null hypothesis tested was that the mean computer anxiety level did not differ among the three observations. The null hypothesis was rejected on the basis of the significant within subjects F ratio shown in Table 16.

Trend analysis using orthogonal polynomial contrasts was conducted in order to identify the trend in the pattern of mean computer anxiety levels. Table 17 displays the results of this analysis by listing the sources of variance, the degrees of freedom, and the F ratios for each contrast.

Table 17

Trend Analysis for Computer Anxiety

| Source | df | F |
|---|---|---|
| Linear | 1 | 48.72* |
| Error (1) | 74 | (74.12) |
| Quadratic | 1 | 6.49** |
| Error (2) | 74 | (30.83) |

Note. Values enclosed in parentheses are mean square errors. N = 75.

*$p < .001$. **$p < .05$.

As is evident from Table 17, the linear and quadratic contrasts were significant. The null hypothesis that there was no linear trend in computer anxiety means was rejected based on the significant linear contrast. Likewise, the null

hypothesis that there was no quadratic trend was rejected based on the significant quadratic contrast.

The linear SS was 3611.31 out of a total SS of 3811.31 and therefore accounted for 94.75% of variability among the three computer anxiety means. The quadratic SS was 200 and accounted for 5.25% of the variability.

Computer confidence. Figure 2 depicts the trend line for computer confidence means.

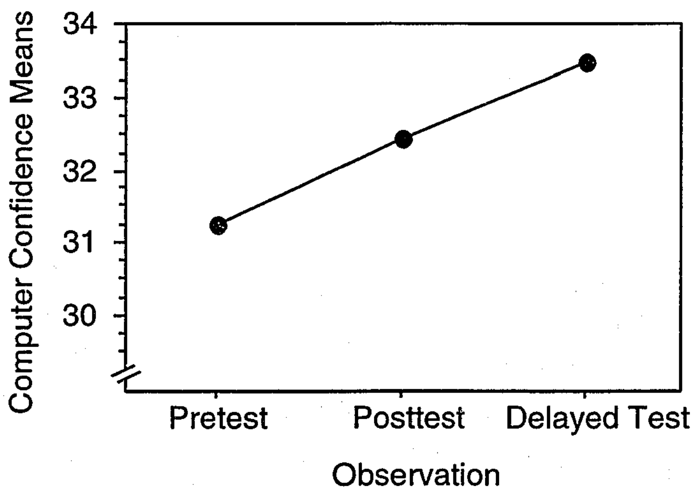


Figure 2. Trend line for computer confidence means.

Figure 2 shows that subject computer confidence levels were at their lowest levels at the pretest observation ($M$ = 31.27, $SD$ = 5.83), at the posttest observation they were higher ($M$ = 32.44, $SD$ = 5.37), and at the delayed test observation they were the highest ($M$ = 33.49, $SD$ = 3.82). A repeated measures ANOVA was conducted to determine whether these observed differences were significant or can be attributable to chance.

The assumption of normality of the distribution of residuals was verified using the residuals scatterplot.

Mauchly's test of sphericity ($W$ = .70) provided evidence of departure from the assumption of sphericity, $\chi^2(2, N = 75) = 26.40$, $p < .001$. Therefore, the within subjects degrees of freedom were adjusted (Huynh-Feldt $\varepsilon$ = .78).

Table 18 shows the results of the repeated measures ANOVA for computer confidence. It contains the sources of variation, the degrees of freedom, and the $F$ ratios.

Table 18

Repeated Measures Analysis of Variance for Computer Confidence

| Source | df | F |
|---|---|---|
| | Between subjects | |
| Constant | 1 | 3888.72* |
| Subjects (S) | 74 | (60.74) |
| | Within subjects | |
| Observations (O) | 1.56 | 11.11* |
| S x O | 115.47 | (8.37) |

Note. Values enclosed in parentheses are mean square errors. $N$ = 75.

*$p$ < .001.

The between subjects null hypothesis tested was that there were no differences in computer confidence levels. Based on the significant *F* ratio for the between subjects constant effect the null hypothesis was rejected.

The within subjects null hypothesis tested was that the mean computer confidence level did not differ among the three observations. The null hypothesis was rejected on the basis of the significant within subjects *F* ratio.

Trend analysis using orthogonal polynomial contrasts was conducted in order to identify the trend in the pattern of mean computer confidence levels. Table 19 displays the results of this analysis by listing the sources of variance, the degrees of freedom, and the *F* ratios.

Table 19

Trend Analysis for Computer Confidence

| Source | *df* | *F* |
|---|---|---|
| Linear | 1 | 17.04* |
| Error (1) | 74 | (10.91) |
| Quadratic | 1 | .03 |
| Error (2) | 74 | (5.83) |

*Note.* Values enclosed in parentheses are mean square errors.

*N* = 75.

$^*p < .001$.

As is evident from Table 19, only the linear contrast was significant. The null hypothesis that there was no linear trend in computer confidence means across the three observations was rejected based on the significant linear contrast. Insufficient evidence existed to reject the null hypothesis that there was no quadratic trend in computer confidence means across the three observations.

Computer liking. Figure 3 depicts the trend line for computer liking means.

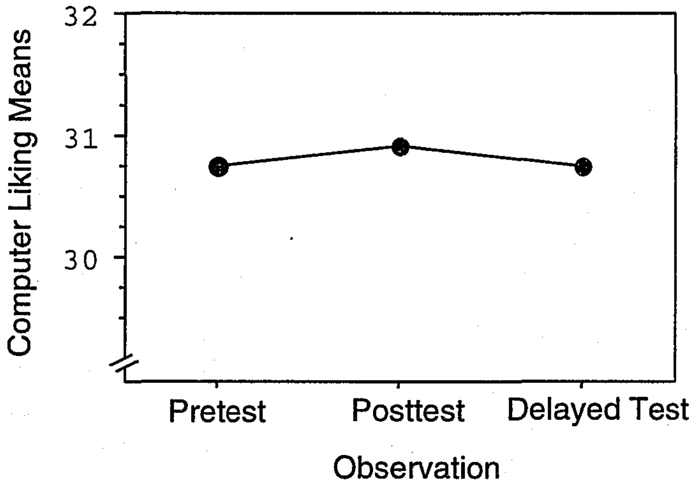


Figure 3. Trend line for computer liking means.

Figure 3 shows that subject computer liking levels were at their highest mean level at the posttest observation ($M$ = 30.92, $SD$ = 4.86), they were at their lowest mean level at the delayed test observation ($M$ = 30.75, $SD$ = 4.71), and they were between the delayed test and posttest mean levels at the pretest observation ($M$ = 30.76, $SD$ = 4.97). A repeated measures ANOVA was conducted to determine whether these

observed differences were significant or can be attributable to chance.

The assumption of normality of the residuals distribution was verified using the residuals scatterplot. Mauchly's test of sphericity ($W$ = .98) showed the sphericity assumption was tenable, $\chi^2(2, N = 75) = 1.78$, $p = .41$.

Table 20 shows the results of the repeated measures ANOVA for computer liking. It contains the sources of variation, the degrees of freedom, and the $F$ ratios.

Table 20

Repeated Measures Analysis of Variance for Computer Liking

| Source | *df* | *F* |
|---|---|---|
| | Between subjects | |
| Constant | 1 | 3912.41* |
| Subjects (S) | 74 | (54.59) |
| | Within subjects | |
| Observations (O) | 2 | .09 |
| S x O | 148 | (7.92) |

Note. Values enclosed in parentheses are mean square errors. $N$ = 75.

*$p$ < .001.

The between subjects null hypothesis tested was that there were no differences in computer liking levels. Based on

the data displayed in Table 20 the null hypothesis was rejected on the basis of the significant F ratio for the between subjects effect.

The within subjects null hypothesis tested was that the mean computer liking level did not differ among the three observations. There was insufficient evidence to reject the null hypothesis based on the nonsignificant F ratio.

Computer usefulness. Figure 4 depicts the trend line for computer usefulness means.

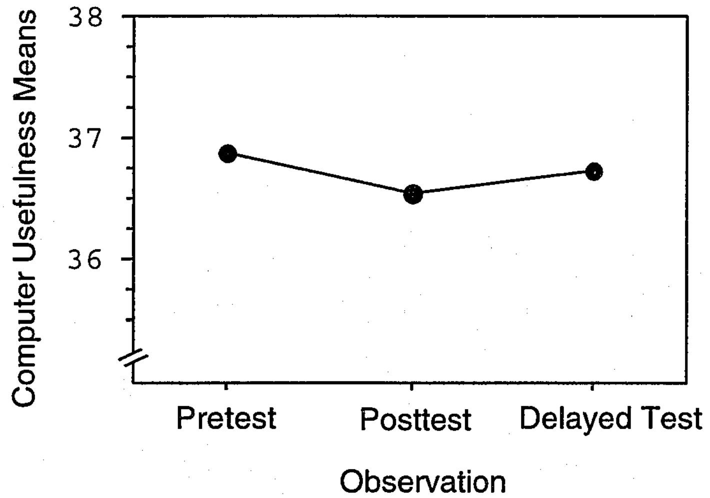


Figure 4. Trend line for computer usefulness means.

Figure 4 shows that subject computer usefulness levels were highest at the pretest observation ($M$ = 36.87, $SD$ = 2.62), they were lowest at the posttest observation ($M$ = 36.53, $SD$ = 2.91), and they were between these levels at the delayed test observation ($M$ = 36.73, $SD$ = 2.32). A repeated measures ANOVA was conducted to determine whether these observed differences were significant.

The assumption of normality of the distribution of residuals was verified using the residuals scatterplot.

Mauchly's test of sphericity ($W$ = .96) showed the sphericity assumption was tenable, $\chi^2(2, N = 75) = 2.83$, $p$ = .24.

Table 21 shows the results of the repeated measures ANOVA for computer anxiety. It contains the sources of variation, the degrees of freedom, and the $F$ ratios.

Table 21

Repeated Measures Analysis of Variance for Computer Usefulness

| Source | df | F |
|---|---|---|
| | Between subjects | |
| Constant | 1 | 23967.92* |
| Subjects (S) | 74 | (12.65) |
| | Within subjects | |
| Observations (O) | 2 | .52 |
| S x O | 148 | (4.03) |

Note. Values enclosed in parentheses are mean square errors.

$N$ = 75.

*$p$ < .001.

The between subjects null hypothesis tested was that there were no differences in mean computer usefulness levels.

Based on the data displayed in Table 21 the null hypothesis was rejected on the basis of the significant F ratio for the between subjects effect.

The within subjects null hypothesis tested was that the mean computer usefulness level did not differ among the three observations. There was insufficient evidence to reject the null hypothesis based on the nonsignificant within subjects F ratio.

Instructor effects. Four instructors taught the six sections of ECI 304 conducted during the fall 1995 semester, with instructor number 1 teaching three sections and the remaining instructors each teaching one section. Students in all sections were drawn from the same experimentally accessible population, the venue was identical for each section, the same textbook (Presley & Brown, 1995) was used by each instructor, and course content was similar. Each instructor, in keeping with the overall scope of the course, was free to develop and adopt specific learning outcomes and supporting student experiences, to select levels of learning and methods of instruction, that were deemed appropriate.

Table 22 displays the degrees of freedom, means and standard deviations of pretest and posttest computer anxiety, and results of paired t tests by groups taught by different instructors.

Table 22

Means and Standard Deviations of Pretest and Posttest Computer Anxiety Means and Significance Tests by Instructor

| | | Pretest | | Posttest | | |
|---|---|---|---|---|---|---|
| Group instructor | *df* | *M* | *SD* | *M* | *SD* | *t* |
| Instructor number 1[a] | 43 | 54.72 | 16.39 | 44.89 | 11.43 | -6.00* |
| Instructor number 2[b] | 15 | 52.69 | 12.84 | 51.19 | 9.50 | -.67 |
| Instructor number 3[c] | 15 | 57.38 | 16.12 | 50.00 | 11.58 | -3.17** |
| Instructor number 4[d] | 9 | 47.40 | 9.99 | 43.40 | 8.41 | -1.30 |

*Note.* [a]$n$ = 44. [b]$n$ = 16. [c]$n$ = 16. [d]$n$ = 10.

*$p < .0001$. **$p < .01$.

A one-way ANCOVA was conducted to test the null hypothesis that all four instructors were equally effective in reducing computer anxiety. The dependent variable was posttest computer anxiety and the covariate was pretest computer anxiety.

Results of evaluation of assumptions concerning outliers and normality of sampling distributions were satisfactory.

Based on the nature of scale development and data collection procedures, there was no reason to expect that the assumption of reliability of the pretest computer anxiety covariate was violated to the extent that would be harmful to data analysis.

The assumption of linearity was satisfied by the use of a scatterplot, as illustrated in Figure 5, to confirm that a linear (rather than curvilinear) relationship existed between the covariate (pretest computer anxiety) and the dependent variable (posttest computer anxiety).

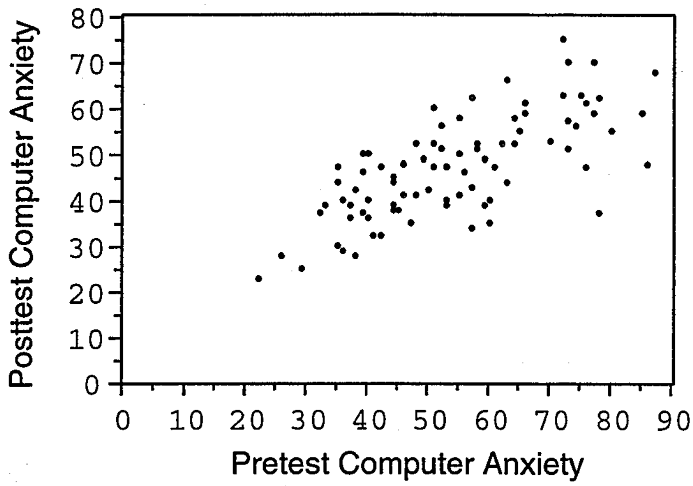


_Figure 5._ Scatterplot of posttest computer anxiety against pretest computer anxiety.

A Bartlett-Box _F_ test was used to test the assumption of homogeneity of variance. The results of the test did not lead to the rejection of the null hypothesis that all population cell variances were equal, $F(3, 6204) = .60$, $p = .61$.

The assumption of homogeneity of regression was tested and found tenable. That is, the Course Instructor x Pretest Computer Anxiety interaction was not significant, $F(3,81) = 2.49$, $p = .07$, therefore there was insufficient evidence to reject the null hypothesis that the regression slope was the same for all four groups.

Table 23 is the ANCOVA table for posttest computer anxiety using pretest computer anxiety as the covariate. It displays the source of variability, degrees of freedom, and the *F* ratios.

Table 23

Analysis of Covariance for Posttest Computer Anxiety with Pretest Computer Anxiety as Covariate

| Source | *df* | *F* |
|---|---|---|
| Course instructor | 3 | 4.31* |
| Regression | 1 | 99.49** |
| Error | 81 | (53.31) |

*Note.* The value enclosed in the parentheses is the mean square error.

*$p$ < .05. **$p$ < .001.

The null hypothesis that there were no differences in mean posttest computer anxiety among groups taught by different instructors was rejected based on the significant instructor effect. The null hypothesis that the common slope is 0 was rejected based on the significant regression effect.

Since Glass and Hopkins (1996) state that the credibility of ANCOVA results is reduced when the amount of extrapolation is large, a check was also made to determine if the adjusted and unadjusted means differed considerably.

Table 24 shows the observed and adjusted posttest computer anxiety means and the amount of extrapolation.

Table 24

Observed and Adjusted Posttest Computer Anxiety Means

| | *M* | | |
|---|---|---|---|
| Group | Observed | Adjusted | Extrapolation |
| Instructor number 1 | 44.89 | 43.95 | -.94 |
| Instructor number 2 | 51.19 | 51.39 | .20 |
| Instructor number 3 | 50.00 | 47.73 | -2.27 |
| Instructor number 4 | 43.40 | 46.40 | 3.00 |

Based on the significant ANCOVA course instructor effect for posttest computer anxiety shown in Table 23, post hoc deviation contrasts were conducted to determine how each group deviated from the overall computer anxiety effect after adjusting for differences in pretest computer anxiety levels. The group taught by instructor number 1 scored significantly lower (i.e., better) than the overall computer anxiety effect, $t(3) = -2.85$, $p < .05$, and the group taught by instructor number 2 scored significantly higher (i.e., worse) than the overall mean computer anxiety effect, $t(3) = 2.55$, $p < .05$. The deviations from the overall effect manifested by the remaining two groups were nonsignificant.

Table 25 displays degrees of freedom, means and standard deviations of pretest and posttest computer confidence, and *t* ratios by groups taught by different instructors.

Table 25

Means and Standard Deviations of Pretest and Posttest Computer Confidence Means and Tests of Significance by Instructor

| | | Pretest | | Posttest | | |
|---|---|---|---|---|---|---|
| Group instructor | *df* | *M* | *SD* | *M* | *SD* | *t* |
| Instructor number 1[a] | 43 | 31.17 | 5.96 | 33.09 | 5.00 | 2.09* |
| Instructor number 2[b] | 15 | 31.44 | 5.15 | 31.56 | 6.15 | .73 |
| Instructor number 3[c] | 15 | 30.39 | 6.23 | 30.31 | 5.04 | .27 |
| Instructor number 4[d] | 9 | 32.50 | 5.44 | 35.10 | 5.15 | 1.78 |

*Note.* [a]$n$ = 44. [b]$n$ = 16. [c]$n$ = 16. [d]$n$ = 10.

*$p < .05$.

A one-way ANCOVA was conducted to test the null hypothesis that all four course instructors were equally effective in increasing computer confidence. The dependent variable was posttest computer confidence and the covariate was pretest computer confidence.

Results of evaluation of assumptions concerning outliers and normality of sampling distributions were satisfactory.

The assumption of linearity was satisfied by the use of a scatterplot, as illustrated in Figure 6, to confirm that a linear (rather than curvilinear) relationship existed between the covariate (pretest computer confidence) and the dependent variable (posttest computer confidence).

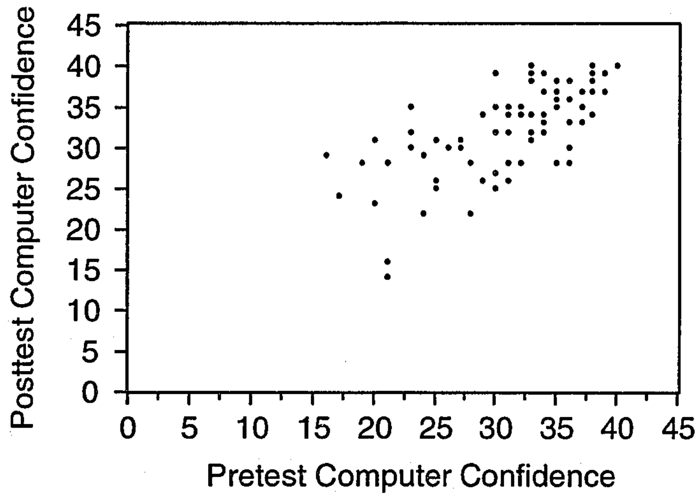


Figure 6. Scatterplot of posttest computer confidence against pretest computer confidence.

A Bartlett-Box $F$ test was used to test the assumption of homogeneity of variance. The results of the test did not lead to the rejection of the null hypothesis that all population cell variances were equal, $F(3, 6204) = .36$, $p = .79$.

The assumption of homogeneity of regression was tested and found tenable. That is, the Course Instructor x Pretest Computer Confidence interaction was not significant, $F(3, 81) = 2.19$, $p = .10$, therefore there was insufficient evidence to reject the null hypothesis that the regression slope was the same for all four groups.

Table 26 is the ANCOVA table for posttest computer confidence using pretest computer confidence as the covariate. The source of variability, degrees of freedom, and the _F_ ratios are displayed.

Table 26

Analysis of Covariance for Posttest Computer Confidence with Pretest Computer Confidence as Covariate

| Source | _df_ | _F_ |
|---|---|---|
| Course instructor | 3 | 1.95 |
| Regression | 1 | 74.55* |
| Error | 81 | (14.54) |

Note. The value enclosed in the parentheses is the mean square error.

*$p < .001$.

There was insufficient evidence to reject the null hypothesis that there were no differences in mean posttest computer confidence scores among groups taught by different instructors. The null hypothesis that the common slope is 0 was rejected based on the significant regression effect.

Since Glass and Hopkins (1996) state that the credibility of ANCOVA results is reduced when the amount of extrapolation is large, a check was also made to determine if the adjusted and unadjusted means differed considerably.

Table 27 shows the observed and adjusted posttest computer confidence means and the amount of extrapolation.

Table 27

Observed and Adjusted Posttest Computer Confidence Means

| | M | | |
|---|---|---|---|
| Group | Observed | Adjusted | Extrapolation |
| Instructor number 1 | 33.09 | 33.03 | -.06 |
| Instructor number 2 | 31.56 | 31.70 | -.14 |
| Instructor number 3 | 30.31 | 30.31 | 0 |
| Instructor number 4 | 35.10 | 34.27 | -.83 |

Based on the absence of a significant ANCOVA course instructor effect for posttest computer confidence, there was no need to conduct post hoc analyses.

Course evaluation. Groups taught by different instructors were also assessed on how each group evaluated the course. In accordance with university policy, all ECI 304 students were afforded the opportunity to complete a course evaluation form anonymously at the end of the fall 1995 semester. The seven pertinent questions used in this evaluation are contained in Appendix K.

The means and standard deviations of student responses to each of the course evaluation questions are aggregated in

Table 28 by groups taught by each of the four instructors who taught ECI 304 sections.

Table 28

Responses to Course Evaluation Questions by Instructor

| Question number | Course instructor number 1[a] *M* | *SD* | 2[b] *M* | *SD* | 3[c] *M* | *SD* | 4[d] *M* | *SD* |
|---|---|---|---|---|---|---|---|---|
| 1. | 5.47 | .69 | 5.35 | .61 | 4.85 | 1.14 | 5.29 | .73 |
| 2. | 5.51 | .66 | 5.24 | .99 | 4.85 | .99 | 5.14 | .77 |
| 3. | 5.73 | .54 | 4.76 | .90 | 5.54 | .66 | 5.86 | .36 |
| 4. | 5.62 | .61 | 5.64 | .49 | 5.23 | .93 | 5.57 | .65 |
| 5. | 5.51 | .73 | 5.06 | .66 | 5.00 | .82 | 5.29 | .83 |
| 6. | 5.42 | .84 | 5.23 | .66 | 5.08 | .95 | 5.21 | .98 |
| 7. | 5.38 | .78 | 4.94 | .90 | 4.69 | 1.18 | 5.21 | .80 |

*Note.* [a]*n* = 45. [b]*n* = 13. [c]*n* = 17. [d]*n* = 14.

Responses were based on a 6-point scale (1 = *unacceptable*, 2 = *poor*, 3 = *acceptable*, 4 = *good*, 5 = *very good*, and 6 = *excellent*).

A one-way multivariate analysis of variance (MANOVA) was performed to test the null hypothesis that the four groups did not differ on their course evaluations. The independent variable was group instructor (four levels: instructor number 1, instructor number 2, instructor number 3, and instructor

number 4). The seven dependent variables were student evaluations in response to each of the seven questions contained on the course evaluation form (see Appendix K).

Means and standard deviations of variables were plausible, no out-of-range values were identified, and no data were missing. Boxplots confirmed the absence of extreme univariate outliers (cases over three box-lengths from the upper or lower edge of the box) and no multivariate outliers were identified using the criterion of $p < .001$ for Mahalanobis distance. Results of the evaluation of the assumptions of multivariate normality, linearity, and multicollinearity were also satisfactory. However, the assumption of homogeneity of variance-covariance matrices was not tenable based on the unequal sample sizes and the significance of Box's $M$ test, $M = 174.05$, $F(84, 5827) = 1.65$, $p < .001$. Since cells with smaller sample sizes produced larger variances, use of Wilks's lambda ($\lambda$) to evaluate multivariate significance is too liberal. Accordingly, Pillai's criterion was used instead of Wilks's $\lambda$ because it is robust to violations and is recommended by Tabachnick and Fidell (1989) given the circumstances that were encountered.

Pillai's criterion showed that the combined dependent variables were significantly affected by the instructor, $F(21, 243) = 3.01$, $p < .001$. Consequently the null hypothesis that the four groups did not differ was rejected. To identify

the dependent variable(s) on which each group differed significantly, seven univariate post hoc $F$ tests were performed, one for each of the seven questions. These tests showed significance for the following two questions:

1. Question number 2, "Rate the instructor's ability to communicate ideas effectively," $F(3, 85) = 3.03$, $p < .05$.
2. Question number 3, "Rate instructor's consistency/punctuality meeting class & using allotted time," $F(3, 85) = 11.49$, $p < .001$.

To determine how the groups differed from the overall mean on each of these two questions, post hoc deviation contrasts (Glass & Hopkins, 1996; Norusis, 1994) were conducted with the following results:

1. Question number 2: instructor number 1, $t(3) = 2.74$, $p < .05$, was significantly higher than the overall mean.
2. Question number 3: instructor number 1, $t(3) = 2.62$, $p < .05$, and instructor number 4, $t(3) = 2.76$, $p < .05$, were significantly higher than the overall mean, and instructor number 2, $t(3) = -5.45$, $p < .001$, was significantly lower than the overall mean.

Research Question Number 2

Introduction. Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the end of a computer literacy course and what optimum weight should be associated with each predictor?

To answer this question a multiple regression was performed between computer anxiety, the criterion variable measured at the posttest observation, and the following predictor variables: computer confidence, computer experience, computer knowledge, computer liking, computer usefulness, locus of control, and trait anxiety.

All the predictor variables were measured at the posttest observation except for locus of control and trait anxiety which were measured at the pretest observation.

Posttest observation data were missing for the six posttest observation dropouts. These dropouts were deleted from the data analyses resulting in a sample size of $N = 86$ for research question number 2.

Regression analysis. Data screening revealed: (a) means and standard deviations of all variables were plausible, (b) no out-of-range values were identified, and (c) no data were missing. Boxplots for each variable confirmed that there were no extreme univariate outliers (cases over three box-lengths from the upper or lower edge of the box). Additionally, no multivariate outliers were identified among any of the cases using the criterion of $p < .001$ for Mahalanobis distance.

One of the first steps in calculating a regression equation with several predictor variables is to calculate a correlation matrix for all the variables. Of particular interest were any large intercorrelations between pairs of

predictor variables, since such correlations can substantially affect the results of multiple regression analysis.

Table 29 is a correlation matrix which shows the Pearson r correlations for the criterion variable and all predictor variables.

Table 29

Correlation Matrix for Criterion and Predictor Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Computer anxiety[a] | -- | -.77 | -.27 | -.44 | -.65 | -.33 | .20 | .49 |
| 2. Computer confidence[b] | | -- | .24 | .40 | .77 | .53 | -.25 | -.36 |
| 3. Computer experience[b] | | | -- | .59 | .08 | .08 | -.11 | -.05 |
| 4. Computer knowledge[b] | | | | -- | .22 | .16 | .05 | -.01 |
| 5. Computer liking[b] | | | | | -- | .56 | -.22 | -.25 |
| 6. Computer usefulness[b] | | | | | | -- | -.16 | -.04 |
| 7. Locus of control[b] | | | | | | | -- | .38 |
| 8. Trait anxiety[b] | | | | | | | | -- |

Note. [a]Criterion variable. [b]Predictor variables.

$N = 86$.

A stepwise multiple regression using backward deletion was performed between posttest computer anxiety as the criterion variable and computer confidence, computer experience, computer knowledge, computer liking, computer usefulness, locus of control, and trait anxiety as predictor

variables. Stepwise multiple regression was used to develop a subset of predictor variables that would be useful in predicting posttest computer anxiety, and to eliminate those predictor variables that did not provide significant additional prediction.

At Step 1 all variables were entered into the regression equation. Thereafter, the variables were removed one at a time based on the probability of $F$ of .05 or greater. At Step 2 computer experience, the variable with the smallest partial correlation coefficient at Step 1, was removed because the probability of its $t$, $p = .70$, was greater than the removal criterion of .05. At Step 3 locus of control, the variable with the smallest partial correlation coefficient at Step 2, was removed because the probability of its $t$, $p = .51$, was greater than the removal criterion. At Step 4 computer usefulness, the variable with the smallest partial correlation coefficient at Step 3, was removed because the probability of its $t$, $p = .29$, was greater than the removal criterion. At Step 4 none of the remaining predictors met the removal criterion of .05, so the backward deletion stopped at this point.

Table 30 displays the unstandardized regression coefficients ($B$), the standard errors of the predicted values ($SE$ $B$), the standardized regression coefficients ($\beta$), and the

t ratios for Step 1 and Step 4 (the first and last steps of the regression analysis).

Table 30

Summary of Stepwise Regression Analysis Using All Predictor Variables to Predict Posttest Computer Anxiety

| Variable | B | SE B | β | t |
|---|---|---|---|---|
| Step 1 | | | | |
| Computer confidence | -.93 | .23 | -.45 | -3.96* |
| Computer experience | -.07 | .17 | -.03 | -.39 |
| Computer knowledge | -.44 | .19 | -.19 | -2.31** |
| Computer liking | -.53 | .23 | -.24 | -2.34** |
| Computer usefulness | .29 | .29 | .08 | 1.01 |
| Locus of control | -.14 | .19 | -.05 | -.73 |
| Trait anxiety | .33 | .08 | .28 | 3.93* |
| Step 4 | | | | |
| Computer confidence | -.87 | .23 | -.42 | -3.84* |
| Computer knowledge | -.51 | .16 | -.22 | -3.19*** |
| Computer liking | -.45 | .22 | -.21 | -2.10** |
| Trait anxiety | .33 | .08 | .28 | 4.22* |

Note. $R = .84$ and $R^2 = .70$ for Step 1 through Step 3; $R = .83$ and $R^2 = .69$ for Step 4.

$N = 86$.

*$p < .001$. **$p < .05$. ***$p < .01$.

Since the sample $\underline{R}^2$ in any multiple regression tends to be an optimistic estimate of how well the model fits the population, an adjusted $\underline{R}^2$ was calculated to more closely reflect the goodness of fit of the model to the population (Norusis, 1994). For Step 1 the adjusted $\underline{R}^2$ was .67 and for Step 2 through Step 4 the adjusted $\underline{R}^2$ was .68.

The standard error of the estimate was 6.27 at Step 4. Thus one would expect the observed value of posttest computer anxiety to fall inside plus or minus 6.27 of the predicted value of posttest computer anxiety 68% of the time.

At Step 4, -1.32 to -.42 was the 95% confidence interval for the computer confidence $\underline{B}$ coefficient, -.82 to -.19 was the 95% confidence interval for the computer knowledge $\underline{B}$ coefficient, -.88 to -.02 was the 95% confidence interval for the computer liking $\underline{B}$ coefficient, and .17 to .48 was the 95% confidence interval for the trait anxiety $\underline{B}$ coefficient.

The multiple regression analysis using the least squares solution yielded the following equation:

$$y' = 84.04 - .87x_1 - .51x_2 - .45x_3 + .33x_4$$

where y' is the predicted posttest computer anxiety score, $x_1$ is the computer confidence score, $x_2$ is the computer knowledge score, $x_3$ is the computer liking score, and $x_4$ is the trait anxiety score.

The null hypothesis that the multiple regression in the population was zero was tested using an ANOVA. Table 31 provides a summary of this analysis. It displays the source of variability (i.e., the observed variability attributable to the regression (labeled Regression) and the observed variability that was not attributable to the regression (labeled Error)), degrees of freedom, and the $F$ ratio.

Table 31

Analysis of Variance for the Multiple Linear Regression Model Using Backward Deletion

| Source | df | $F$ |
|---|---|---|
| Regression | 4 | 45.71* |
| Error | 81 | (39.30) |

Note. The value enclosed in the parentheses is the mean square error.

$N$ = 86.

*$p$ < .0001.

Since Table 31 shows that the regression solution is highly significant, the null hypothesis was rejected.

The Durbin-Watson test was used to test the assumption of independence of residuals. For the sample used in this study the Durbin-Watson statistic was 2.22, which implies a low degree of correlation between residuals.

The assumption that the mean unstandardized residual value is zero was checked and satisfied (minimum = -13.65, maximum = 15.85, M = 0, SD = 6.12, N = 86).

Multiple regression also assumes normality (residuals are normally distributed around each predicted posttest computer anxiety score), linearity (residuals have a linear relationship with predicted scores), and homoscedasticity (the variance of the residuals about the predicted scores is the same for all predicted scores). The residuals scatterplot, Figure 7, provides evidence that these assumptions are tenable.

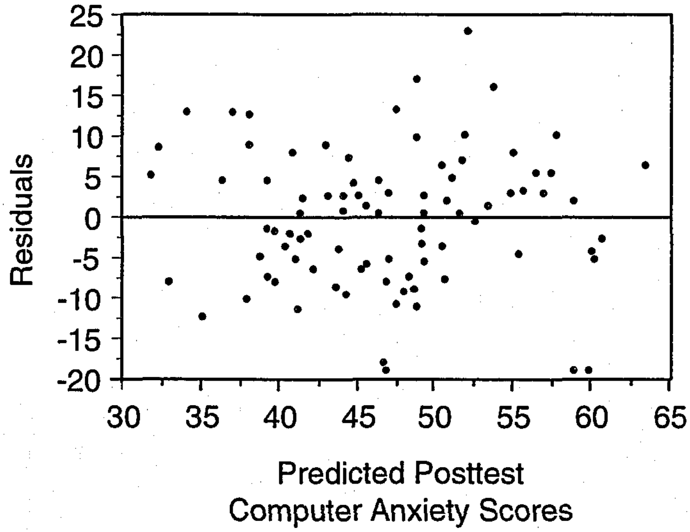


Figure 7. Scatterplot of residuals against predicted posttest computer anxiety scores.

Perfect multicollinearity among the predictors results in the failure of the least squares criterion to yield a satisfactory solution (Berry, 1993). To check for

multicollinearity, eigenvalues of the scaled, uncentered cross-product matrices were examined to determine if the data matrices were ill-conditioned. If a matrix is ill-conditioned, small changes in the values of the criterion variable or predictor variables can lead to large changes in the solution.

Table 32 presents the results of collinearity diagnostics for the regression solution at Step 4. It shows the eigenvalues, condition indexes, and variance proportions.

Table 32

Collinearity Summary for the Regression Analysis Using Predictor Variables at Step 4

| | | Condition | Variance Proportions | | | | |
|---|---|---|---|---|---|---|---|
| Number | Eigenvalue | Index | 1 | 2 | 3 | 4 | 5 |
| 1 | 4.84 | 1.00 | .00 | .00 | .00 | .00 | .00 |
| 2 | .08 | 7.62 | .00 | .00 | .43 | .00 | .28 |
| 3 | .06 | 9.11 | .01 | .03 | .46 | .04 | .20 |
| 4 | .01 | 23.61 | .92 | .02 | .00 | .23 | .40 |
| 5 | .00 | 31.25 | .07 | .95 | .10 | .74 | .12 |

Note. Variance proportions: 1. Constant, 2. Computer confidence, 3. Computer knowledge, 4. Computer liking, and 5. Trait anxiety.

Variables with high variance proportions for the same eigenvalue provide evidence of collinearity. As Table 32 shows, the condition indexes of 23.61 and 31.25 for the fourth and fifth eigenvalues are relatively large, thus flagging a potential collinearity condition. The fourth eigenvalue accounts for 92% of the variance of the constant, 23% of the variance of computer liking, and 40% of the variance of trait anxiety. The fifth eigenvalue accounts for 95% of the variance of computer confidence and 74% of the variance of computer liking.

Cross-validation. The spring 1996 semester sample (calibration sample) was used to conduct a cross-validation of the regression equation obtained from the fall 1995 semester sample (screening sample). Cross-validation was performed in order to estimate the amount of shrinkage of the multiple regression equation when applied to a new sample.

The Pearson $r$ correlation coefficient (analogous to the multiple correlation coefficient $R$) between the observed posttest computer anxiety scores and the predicted posttest computer anxiety scores in the spring 1996 semester sample was .80, resulting in an estimated $R^2$ equal to .64. The amount of shrinkage was .05 (the difference between the $R^2$ of the fall 1995 semester sample and the estimated $R^2$ of the spring 1996 semester sample).

Since the shrinkage was low and the $R^2$ was meaningful, a refined multiple regression analysis was conducted using a combined sample ($N$ = 143) that consisted of both the fall 1995 semester sample and the spring 1996 semester sample.

Boxplots confirmed the absence of extreme univariate outliers and Mahalanobis distance using the criterion of $p$ < .001 confirmed the absence of multivariate outliers.

Table 33 is the correlation matrix for the new sample which shows the Pearson $r$ correlations for the criterion variable and all the predictor variables.

Table 33

Correlation Matrix for Criterion and Predictor Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Computer anxiety[a] | -- | -.78 | -.30 | -.44 | -.62 | -.35 | .23 | .43 |
| 2. Computer confidence[b] | | -- | .25 | .37 | .75 | .52 | -.20 | -.29 |
| 3. Computer experience[b] | | | -- | .57 | .12 | .11 | -.11 | -.02 |
| 4. Computer knowledge[b] | | | | -- | .27 | .23 | .02 | -.05 |
| 5. Computer liking[b] | | | | | -- | .60 | -.17 | -.18 |
| 6. Computer usefulness[b] | | | | | | -- | -.12 | -.05 |
| 7. Locus of control[b] | | | | | | | -- | .33 |
| 8. Trait anxiety[b] | | | | | | | | -- |

Note. [a]Criterion variable. [b]Predictor variables.

$N$ = 143.

A stepwise multiple regression using backward deletion was performed between posttest computer anxiety as the criterion variable and computer confidence, computer experience, computer knowledge, computer liking, computer usefulness, locus of control, and trait anxiety as predictor variables.

At Step 1 all variables were entered into the regression equation. At Step 2 locus of control, the variable with the smallest partial correlation coefficient at Step 1, was removed because the probability of its $\underline{t}$, $\underline{p} = .66$, was greater than the removal criterion of .05. At Step 3 computer experience, the variable with the smallest partial correlation coefficient at Step 2, was removed because the probability of its $\underline{t}$, $\underline{p} = .57$, was greater than the removal criterion. At Step 4 computer usefulness, the variable with the smallest partial correlation coefficient at Step 3, was removed because the probability of its $\underline{t}$, $\underline{p} = .41$, was greater than the removal criterion. At Step 5 computer liking, the variable with the smallest partial correlation coefficient at Step 4, was removed because the probability of its $\underline{t}$, $\underline{p} = .09$, was greater than the removal criterion. At Step 5 none of the remaining predictors met the removal criterion of .05, so the backward deletion stopped at this point.

Table 34 displays the unstandardized regression coefficients (B), the standard errors of the predicted values (SE B), the standardized regression coefficients (β), and the t ratios for Step 1 and Step 5 (the first and last steps).

Table 34

Summary of Stepwise Regression Analysis to Predict Posttest Computer Anxiety in the Combined Sample

| Variable | B | SE B | β | t |
|---|---|---|---|---|
| Step 1 | | | | |
| Computer confidence | -1.16 | .17 | -.54 | -6.87* |
| Computer experience | -.06 | .13 | -.03 | -.49 |
| Computer knowledge | -.42 | .12 | -.21 | -3.35** |
| Computer liking | -.32 | .17 | -.15 | -1.90 |
| Computer usefulness | .20 | .24 | .05 | .85 |
| Locus of control | .06 | .14 | .02 | .44 |
| Trait anxiety | .31 | .07 | .25 | 4.66* |
| Step 5 | | | | |
| Computer confidence | -1.34 | .12 | -.62 | -11.52* |
| Computer knowledge | -.44 | .10 | -.22 | -4.22* |
| Trait anxiety | .33 | .06 | .26 | 5.26* |

Note. $R = .84$ and $R^2 = .70$ for Step 1 through Step 4; $R = .83$ and $R^2 = .69$ for Step 5.

$N = 143$.

*$p < .0001$. **$p < .01$.

For all steps the adjusted $R^2$ was .69.

The standard error of the estimate was 6.16 at Step 5. Thus one would expect the observed value of posttest computer anxiety to fall inside plus or minus 6.16 of the predicted value of posttest computer anxiety 68% of the time.

At Step 5, -1.57 to -1.11 was the 95% confidence interval for the computer confidence B coefficient, -.65 to -.23 was the 95% confidence interval for the computer knowledge B coefficient, and .20 to .45 was the 95% confidence interval for the trait anxiety B coefficient.

The multiple regression analysis using the least squares solution yielded the following equation:

$$y' = 83.93 - 1.34x_1 - .44x_2 + .33x_3$$

where y' is the predicted posttest computer anxiety score, $x_1$ is the computer confidence score, $x_2$ is the computer knowledge score, and $x_3$ is the trait anxiety score.

The null hypothesis that the multiple regression in the population was zero was tested using an ANOVA. Table 35 provides a summary of this analysis. It displays the source of variability (i.e., the observed variability attributable to the regression (labeled Regression) and the observed variability that was not attributable to the regression (labeled Error)), degrees of freedom, and the F ratio.

Table 35

Analysis of Variance for the Multiple Linear Regression Model

| Source | df | F |
|---|---|---|
| Regression | 3 | 103.99* |
| Error | 139 | (37.89) |

Note. The value enclosed in the parentheses is the mean square error.

N = 143.

*$p < .0001$.

Since Table 35 shows that the regression solution is highly significant, the null hypothesis was rejected.

The Durbin-Watson test was used to test the assumption of independence of residuals. For the sample used in this study the Durbin-Watson statistic was 2.21, which implies a low degree of correlation between residuals. The assumption that the mean unstandardized residual value is zero was checked and satisfied (minimum = -19.31, maximum = 15.90, M = 0, SD = 6.09, N = 143). Assumptions of normality, linearity, and homoscedasticity between predicted posttest computer anxiety scores and residuals was checked and found tenable by means of a residuals scatterplot. An analysis of eigenvalues and variances proportions at Step 5 showed no evidence of high collinearity among predictors.

Spring 1996 Semester Volunteers and Dropouts

Introduction. The spring 1996 semester subject pool consisted of 71 students. However, three students were not eligible to participate in the study because they were not enrolled in teacher education programs.

Volunteers. Of the 68 students who were eligible to participate, 63 volunteered to participate resulting in a 92.65% volunteer rate. Of the six students who did not volunteer (four were from humanistically-focused treatment groups), three students responded that they did not have the time to participate in the study. Since none of the nonvolunteers agreed to complete the Start-of-Study Questionnaire, a comparative analysis between volunteers and nonvolunteers could not be conducted.

Dropouts. Two subjects dropped out of the study as a result of their withdrawal from ECI 304 during the semester. An additional four subjects dropped out of the study at the end of the semester by failing to complete the posttest questionnaires. A total of six subjects were dropouts resulting in an overall dropout or mortality rate of 9.52%.

Since dropouts were considered a possible source of bias in this study statistical tests were conducted to determine whether dropouts ($n$ = 6) differed from nondropouts ($n$ = 57).

Independent samples $t$ tests were conducted to compare the means of dropouts and nondropouts on pretest observation

interval scale variables. Using the Bartlett-Box F test of homogeneity of variance, the null hypothesis of equal variances was not rejected for any of the interval scale variables analyzed.

Table 36 provides the results of this comparison by listing the relevant degrees of freedom, means, standard deviations, and t ratios.

Table 36

Comparison of Spring 1996 Semester Dropouts and Nondropouts on Interval Scale Variables

| | | Dropouts[a] | | Nondropouts[b] | | |
|---|---|---|---|---|---|---|
| Variable | df | M | SD | M | SD | t |
| Age | 61 | 24.33 | 6.95 | 24.68 | 7.36 | .11 |
| Computer anxiety | 61 | 35.67 | 12.28 | 49.16 | 16.08 | 1.99 |
| Computer confidence | 61 | 34.50 | 5.79 | 32.70 | 5.81 | .72 |
| Computer experience | 61 | 18.00 | 8.20 | 11.14 | 7.20 | 2.19* |
| Computer knowledge | 61 | 19.33 | 7.69 | 11.25 | 7.60 | 2.48* |
| Computer liking | 61 | 33.83 | 6.85 | 31.91 | 5.45 | .80 |
| Computer usefulness | 61 | 36.67 | 2.58 | 36.47 | 3.32 | .14 |
| Locus of control | 61 | 6.83 | 3.13 | 10.47 | 4.14 | 2.09* |
| Trait anxiety | 61 | 33.67 | 3.88 | 38.51 | 7.80 | 1.49 |

Note. [a]N = 6. [b]N = 57.

$p < .05$.

Table 36 shows that dropouts and nondropouts differed significantly on computer experience, computer knowledge, and locus of control.

Additionally, independent proportions $\chi^2$ tests showed no significant differences between dropouts and nondropouts on the nominal scale variables tested: sex, $\chi^2(1, \underline{N} = 63) = .01$; anticipated teaching level, $\chi^2(2, \underline{N} = 63) = 2.44$; and computer ownership, $\chi^2(1, \underline{N} = 63) = 1.56$.

Spring 1996 Semester Data Screening

Data collected on computer anxiety, computer confidence, computer usefulness, computer liking, computer experience, computer knowledge, locus of control, and trait anxiety were examined for accuracy of data entry, missing values, extreme outliers, normality, and multicollinearity.

Means and standard deviations of all variables were plausible, no out-of-range values were identified, and no data were missing (all dropouts were deleted from the data analysis).

Boxplots were used to check each continuous variable for the presence of extreme outliers. Four extremely low computer usefulness pretest outliers and three extremely low computer usefulness posttest outliers were identified.

Normal probability plots were also examined for all continuous variables used in parametric tests of significance. Except for computer usefulness, all points fell

more or less along a straight line thus confirming the assumption of normality for these distributions.

In order to help identify potential multicollinearity and singularity problems, variables measured during the pretest observation are presented in the correlation matrix at Table 37.

Table 37

Intercorrelations Between Pretest Variables from the Spring 1996 Semester Sample

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Computer anxiety | -- | -.82 | -.52 | -.52 | -.72 | -.57 | .14 | .27 |
| 2. Computer confidence | | -- | .54 | .50 | .80 | .67 | -.20 | -.22 |
| 3. Computer experience | | | -- | .63 | .45 | .52 | -.14 | -.02 |
| 4. Computer knowledge | | | | -- | .48 | .35 | -.07 | .06 |
| 5. Computer liking | | | | | -- | .69 | -.18 | -.04 |
| 6. Computer usefulness | | | | | | -- | -.13 | .02 |
| 7. Locus of control | | | | | | | -- | .31 |
| 8. Trait anxiety | | | | | | | | -- |

Note. N = 63.

This table reveals three pairs of variables that are highly correlated ($r > .70$): (a) computer anxiety and computer confidence have a correlation of -.82, (b) computer anxiety and computer liking have a correlation of -.72, and

(c) computer confidence and computer liking have a correlation of .80.

Spring 1996 Semester Descriptive Results

General. Sixty-three volunteers were accepted as participants in the study at the beginning of the spring 1996 semester. Of these, 53 subjects (84.1%) were females and 10 subjects (15.9%) were males. The mean pretest computer anxiety score for females was 47.64 (*SD* = 17.01) and for males was 49.00 (*SD* = 11.36). The average age of all subjects was 24.65 years (*SD* = 7.27) with a range of 18 to 50 years. Three subjects (4.8%) were freshmen, 22 subjects (34.9%) were sophomores, 21 subjects (33.3%) were juniors, 12 subjects (19.0%) were seniors, and 5 subjects (8.0%) were graduate students. Twenty-six subjects (41.3%) planned to be elementary school teachers, 13 subjects (20.6%) planned to be middle school teachers, and 24 subjects (38.1%) planned to be high school teachers.

Fifty-one subjects (81.0%) reported that they owned a personal computer. The mean pretest computer anxiety score for subjects who owned computers was 44.63 (*SD* = 14.65) and for subjects who did not own computers was 61.67 (*SD* = 15.56). The mean posttest computer anxiety score for computer owners was 39.56 (*SD* = 10.58) and for subjects who did not own computers it was 44.92 (*SD* = 4.46).

Table 38 provides percentile scores by level of computer anxiety, as defined by Oetting (1983), for the computer anxiety pretest observation and Oetting's normative study. Raw computer anxiety scores collected at the pretest observation were doubled for use in Table 38 in order to allow comparison with normative study scores. This was done because equivalent COMPAS parallel forms were used to score computer anxiety in the main study and the normative study used scores yielded by the COMPAS long form (both parallel forms administered together).

Table 38

Levels of Computer Anxiety by Raw Scores, Pretest Percentiles, and Normative Study Percentiles for the Spring 1996 Semester Sample

| | | P | |
|---|---|---|---|
| Level | Raw score | Pretest[a] | Normative[b] |
| Very anxious | 160 | 95.2 | 97.9 |
| Anxious/tense | 140 | 90.5 | 93.6 |
| Mild anxiety present | 120 | 76.2 | 83.2 |
| Generally relaxed | 90 | 46.0 | 46.9 |
| Very relaxed | 70 | 27.0 | 23.2 |

Note. [a]N = 63. [b]N = 482.

Cognitively-focused treatment subjects provided the following data at the posttest observation: (a) 1 subject (3.45%) received outside help, such as a tutor, during ECI 304; (b) 2 subjects (6.90%) purchased a computer since they started the study; (c) 27 subjects (93.10%) used a computer at work during the study; (d) 26 subjects (89.66%) used a computer for other courses during the study (all subjects described this use as incidental only, i.e., for the preparation of papers); and (e) 23 subjects (79.31%) stated that their expectations for ECI 304 were satisfied and 6 subjects (20.60%) stated their expectations were only satisfied in part. The following additional responses were recorded: "I thought the course would cover more software programs" and "The course should show how teachers should use computers in the classroom."

Humanistically-focused treatment subjects provided the following data at the posttest observation: (a) 3 subjects (10.71%) received outside help, such as a tutor, during ECI 304; (b) 3 subjects (10.71%) purchased a computer since they started the study; (c) 27 subjects (96.43%) used a computer at work during the study; (d) 23 subjects (82.14%) used a computer for other courses during the study (all subjects described this use as incidental only, i.e., for the preparation of papers); and (e) 24 subjects (85.71%) stated that their expectations for ECI 304 were satisfied and 4

subjects (14.29%) stated their expectations were only satisfied in part. The following additional responses were recorded: "I think that we were extremely rushed," "We needed more time using the Macintosh computer," and "We needed more time with the computer and it was very hard to work out time given the very limited lab hours."

Using 5-point Likert scales, subjects also provided their ratings of the importance of computers to teachers and of their intention to use computers in the classroom at the posttest observation. To the question "How important is it for teachers to use computer technology in the classroom to assist and/or manage instruction?" cognitively-focused treatment subjects responded with a mean rating of 4.38 (SD = .73) and humanistically-focused treatment subjects responded with a mean rating of 4.46 (SD = .69) on a scale that ranged from 5 (extremely important) to 1 (not important). To the question "How would you presently describe your intention of using computer technology in the classroom to assist and/or manage instruction when you become a teacher, assuming the hardware and software you need are available?" cognitively-focused treatment subjects responded with a mean rating of 4.52 (SD = .69) and humanistically-focused treatment subjects responded with a mean rating of 4.50 (SD = .58) on a scale that ranged from 5 (extremely likely to use computers) to 1 (not likely to use computers).

Comparison of subjects by treatment and by instructor. Subjects were divided by two factors: treatment type and course instructor, with each factor consisting of two levels or groups (i.e., two treatment types and two instructors). Raw score means and standard deviations for pretest observation variables by subjects grouped by treatment type are summarized in Table 39.

Table 39

Means and Standard Deviations of Pretest Observation Variables by Treatment Type

| | Cognitive[a] | | Humanistic[b] | |
|---|---|---|---|---|
| Variable | M | SD | M | SD |
| Computer anxiety | 47.72 | 15.53 | 48.03 | 17.07 |
| Computer confidence | 32.47 | 5.57 | 33.29 | 6.06 |
| Computer experience | 11.25 | 6.47 | 12.36 | 8.52 |
| Computer knowledge | 10.34 | 7.60 | 13.74 | 7.98 |
| Computer liking | 32.19 | 5.44 | 32.00 | 5.77 |
| Computer usefulness | 36.41 | 3.46 | 36.58 | 3.05 |
| Locus of control | 10.19 | 4.48 | 10.07 | 3.91 |
| Trait anxiety | 38.31 | 7.00 | 37.77 | 8.33 |

Note. [a]N = 32. [b]N = 31.

Raw score means and standard deviations for pretest observation variables by subjects grouped by teacher are summarized in Table 40.

Table 40

Means and Standard Deviations of Pretest Observation Variables by Instructor

| | Instructor 1[a] | | Instructor 2[b] | |
|---|---|---|---|---|
| Variable | M | SD | M | SD |
| Computer anxiety | 45.04 | 15.21 | 50.14 | 16.78 |
| Computer confidence | 33.61 | 5.59 | 32.29 | 5.95 |
| Computer experience | 12.86 | 7.84 | 10.94 | 7.24 |
| Computer knowledge | 13.50 | 8.69 | 10.83 | 7.14 |
| Computer liking | 31.71 | 6.31 | 32.40 | 4.96 |
| Computer usefulness | 36.50 | 3.38 | 36.49 | 3.18 |
| Locus of control | 10.61 | 4.48 | 9.74 | 3.94 |
| Trait anxiety | 37.50 | 7.08 | 38.49 | 8.12 |

Note. [a]N = 28. [b]N = 35.

Comparison of treatments. Table 41 shows the percentile of instruction by method of instruction for each treatment type by course instructor. Methods of instruction were categorized as follows:

1. Presentation method: included lecture, panel discussion, demonstration-performance, reading, and self-paced programmed instruction.

2. Verbal interaction method: included both guided and nondirected discussion.

3. Application method: included individual and group projects using the computer, case studies, and simulations.

Data tabulated in Table 41 were obtained from instructor journals and were periodically checked for accuracy by two independent observers.

Table 41

Percentile of Instruction by Method of Instruction for each Treatment Type by Instructor

| | Method of instruction | | |
|---|---|---|---|
| Treatment type | Presentation | Verbal Interaction | Application |
| Cognitively-focused | | | |
| Instructor number 1 | .33 | .02 | .65 |
| Instructor number 2 | .32 | .02 | .66 |
| Humanistically-focused | | | |
| Instructor number 1 | .21 | .10 | .69 |
| Instructor number 2 | .20 | .19 | .61 |

Note. Rows add to 1.00.

Teacher-initiated interactions between the instructor and students were sampled during checks by the independent observers using the observation form at Appendix I. Observers scored interactions as either cognitive (e.g., how do you copy a file?) or affective (e.g., how important is this lesson to you?). Table 42 shows the percentile of type of interactions for each treatment type by instructor.

Table 42

Percentile of Teacher-Initiated Interactions by Interaction Type for each Treatment Type by Instructor

| | Interaction type | |
|---|---|---|
| Treatment type | Cognitive | Affective |
| Cognitively-focused | | |
| Instructor number 1 | .92 | .08 |
| Instructor number 2 | .95 | .05 |
| Humanistically-focused | | |
| Instructor number 1 | .15 | .85 |
| Instructor number 2 | .22 | .78 |

Note. Rows add to 1.00.

A review of instructor journals confirmed that the cognitively-focused treatment, as presented, consisted of the 12 planned cognitive learning outcomes described in Appendix C. Likewise, the humanistically-focused treatment consisted

of the ten planned cognitive learning outcomes and the five planned affective learning outcomes described in Appendix D.

Direct observation protocol. Two independent observers completed observation forms (see Appendix I) for 38 out of 144 class meetings that resulted in a 26.39% observation rate. Each week the researcher compared data on completed observation forms to treatment plans and instructor journals (see Appendixes C and D), and to treatment syllabi (see Appendixes E and F). The results of these weekly comparisons were used by the researcher to check the status of treatment fidelity and to initiate adjustments as necessary.

The exact agreement method was used to check interobserver agreement (Hittleman & Simon, 1992). One cognitively-focused treatment class meeting and one humanistically-focused treatment class meeting were randomly selected each month and checked by both observers. Monthly interobserver agreements for these class meetings, using 24 items, were 83.33% (20 agreements) for January, 95.83% (23 agreements) for February, 100% (24 agreements) for March, and 95.83% (23 agreements) for April, 1996.

Comparison of Pretest and Posttest Scores

Table 43 presents the degrees of freedom, pretest and posttest means and standard deviations, and the results of paired $t$ tests for computer anxiety, computer confidence,

computer liking, and computer usefulness by type of treatment.

Table 43

Comparison of Pretest and Posttest Mean Scores and Tests of Significance by Treatment Type

| | | Pretest[a] | | Posttest[b] | | |
|---|---|---|---|---|---|---|
| Variable | df | M | SD | M | SD | t |
| Cognitively-focused | | | | | | |
| Computer anxiety | 28 | 47.72 | 15.53 | 41.76 | 10.30 | 3.20* |
| Computer confidence | 28 | 32.47 | 5.57 | 36.14 | 4.34 | 4.03** |
| Computer liking | 28 | 32.19 | 5.44 | 32.90 | 5.71 | .59 |
| Computer usefulness | 28 | 36.41 | 3.46 | 37.00 | 2.90 | 1.00 |
| Humanistically-focused | | | | | | |
| Computer anxiety | 27 | 48.03 | 17.07 | 39.57 | 9.39 | 4.44** |
| Computer confidence | 27 | 33.29 | 6.06 | 35.18 | 3.50 | 3.27* |
| Computer liking | 27 | 32.00 | 5.77 | 32.82 | 4.32 | 2.04 |
| Computer usefulness | 27 | 36.58 | 3.05 | 38.36 | 1.45 | 3.30* |

Note. [a]N = 63. [b]N = 57.

*$p < .01$. **$p < .001$.

Table 44 presents the degrees of freedom, pretest and posttest means and standard deviations, and t ratios for computer anxiety, computer confidence, computer liking, and computer usefulness by course instructor.

Table 44

Comparison of Pretest and Posttest Mean Scores and Tests of Significance by Instructor

| Variable | df | Pretest[a] M | Pretest[a] SD | Posttest[b] M | Posttest[b] SD | t |
|---|---|---|---|---|---|---|
| Instructor number 1 | | | | | | |
| Computer anxiety | 23 | 45.04 | 15.21 | 37.63 | 8.73 | 3.37** |
| Computer confidence | 23 | 33.61 | 5.59 | 36.63 | 3.95 | 3.59** |
| Computer liking | 23 | 31.71 | 6.31 | 32.54 | 5.86 | 1.01 |
| Computer usefulness | 23 | 36.50 | 3.38 | 37.42 | 3.26 | 1.66 |
| Instructor number 2 | | | | | | |
| Computer anxiety | 32 | 50.14 | 16.77 | 42.91 | 10.12 | 4.28*** |
| Computer confidence | 32 | 32.29 | 5.95 | 34.97 | 3.85 | 3.77*** |
| Computer liking | 32 | 32.40 | 4.96 | 33.09 | 4.41 | 1.49 |
| Computer usefulness | 32 | 36.49 | 3.18 | 37.85 | 1.50 | 2.59* |

Note. [a]$N$ = 63. [b]$N$ = 57.

*$p$ < .05. **$p$ < .01. ***$p$ < .001.

Research Question Number 3

Introduction. How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and instructor?

To answer this question four 2 x 2 ANCOVAs were conducted, one for each of the following dependent variables

measured at the posttest observation: (a) computer anxiety, (b) computer confidence, (c) computer liking, and (d) computer usefulness. The covariate for each analysis was the dependent variable measured at the pretest observation. The independent variables were: (a) treatment type (two levels: cognitively-focused treatment and humanistically-focused treatment); and (b) course instructor (two levels: instructor number 1 and instructor number 2).

As was the case with the primary analyses of research question number 1, multiple univariate analyses were conducted (versus a single multivariate analysis) because: (a) the research question sought to identify differences in each dependent variable, and (b) the dependent variables were conceptually independent.

Posttest observation data were missing for the six posttest observation dropouts. These dropouts were deleted from the data analysis resulting in a sample size of $\underline{N} = 57$ for research question number 3.

Computer anxiety. Results of evaluation of the assumptions concerning extreme outliers and normality of sampling distributions were satisfactory.

The assumption of linearity between the pretest computer anxiety covariate and posttest computer anxiety was satisfied by visual inspection of the scatterplot of posttest computer

anxiety against pretest computer anxiety, as illustrated in Figure 8.

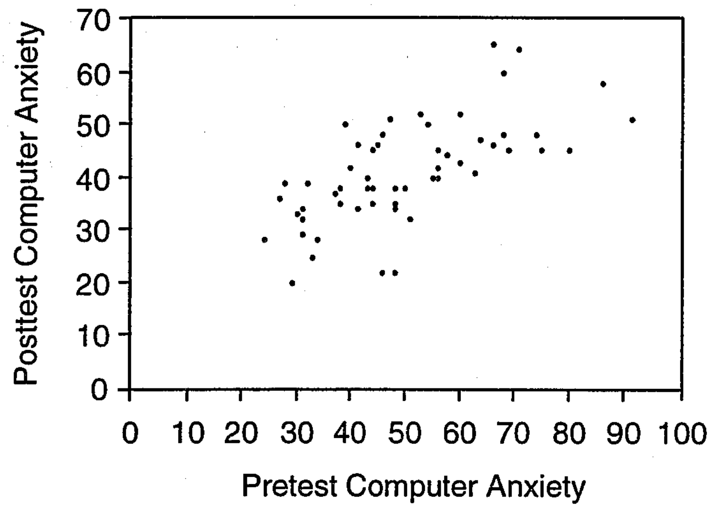


Figure 8. Scatterplot of posttest computer anxiety against pretest computer anxiety.

A Bartlett-Box F test was used to test the assumption of homogeneity of variance. The results of the test did not lead to the rejection of the null hypothesis that all population cell variances were equal, $F(3, 4697) = .38$, $p > .05$.

An ANOVA was conducted to test the assumption of homogeneity of regression. The null hypotheses tested were that the slopes of the regression lines were the same for all groups defined by treatment and by course instructor. The Treatment x Pretest Computer Anxiety interaction, $F(1, 51) = .86$, and the Course Instructor x Pretest Computer Anxiety interaction, $F(1, 51) = .91$, were nonsignificant. Consequently there was insufficient evidence to reject the null hypotheses.

Table 45 is the ANCOVA table for posttest computer anxiety using pretest computer anxiety as the covariate. It displays the sources of variability, degrees of freedom, and the *F* ratios. The source of variability labeled regression is a test of the hypothesis that the common slope is 0.

Table 45

Analysis of Covariance for Posttest Computer Anxiety with Pretest Computer Anxiety as Covariate

| Source | *df* | *F* |
|---|---|---|
| Treatment | 1 | 2.38 |
| Course Instructor | 1 | 2.62 |
| Treatment x Course Instructor | 1 | .33 |
| Regression | 1 | 46.05* |
| Error | 52 | (50.40) |

*Note.* The value in the parentheses is the mean square error.
*$p < .001$.

There was insufficient evidence to reject the null hypotheses that there were no differences in mean posttest computer anxiety between treatments and between groups taught by different teachers. Furthermore, the Treatment x Course Instructor interaction effect was nonsignificant. The null hypothesis that the common slope was 0 was rejected based on the significant regression effect.

Computer confidence. Results of evaluation of the assumptions concerning extreme outliers and normality of sampling distributions were satisfactory.

The assumption of linearity between the pretest computer confidence covariate and posttest computer confidence was satisfied by visual inspection of the scatterplot of posttest computer confidence against pretest computer confidence, as illustrated in Figure 9.

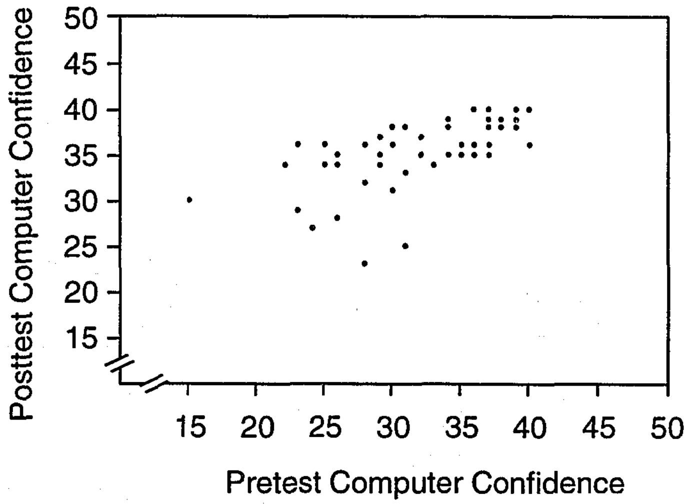


Figure 9. Scatterplot of posttest computer confidence against pretest computer confidence.

A Bartlett-Box $F$ test was used to test the assumption of homogeneity of variance. The results of the test did not lead to the rejection of the null hypothesis that all population cell variances were equal, $F(3, 4697) = 1.27$, $p > .05$.

An ANOVA was conducted to test the assumption of homogeneity of regression. The null hypotheses tested were that the slopes of the regression lines were the same for all

groups defined by treatment and by instructor. The Treatment x Pretest Computer Confidence interaction, $F(1, 51) = .01$, and the Course Instructor x Pretest Computer Confidence interaction, $F(1, 51) = .55$, were nonsignificant. Consequently there was insufficient evidence to reject the null hypotheses.

Table 46 is the ANCOVA table for posttest computer confidence using pretest computer confidence as the covariate. It displays the sources of variability, degrees of freedom, and the $F$ ratios.

Table 46

Analysis of Covariance for Posttest Computer Confidence with Pretest Computer Confidence as Covariate

| Source | df | F |
|---|---|---|
| Treatment | 1 | 1.19 |
| Course Instructor | 1 | 1.02 |
| Treatment x Course Instructor | 1 | .21 |
| Regression | 1 | 41.46* |
| Error | 52 | (8.74) |

Note. The value in the parentheses is the mean square error.

*$p < .001$.

There was insufficient evidence to reject the null hypotheses that there were no differences in mean posttest computer confidence between treatments and between groups

taught by different instructors. Furthermore, the Treatment x Course Instructor interaction effect was nonsignificant. The null hypothesis that the common slope was 0 was rejected based on the significant regression effect.

Computer liking. Results of evaluation of the assumptions concerning extreme outliers and normality of sampling distributions were satisfactory.

The assumption of linearity between the pretest computer liking covariate and posttest computer liking was satisfied by visual inspection of the scatterplot of posttest computer liking against pretest computer liking, as illustrated in Figure 10.

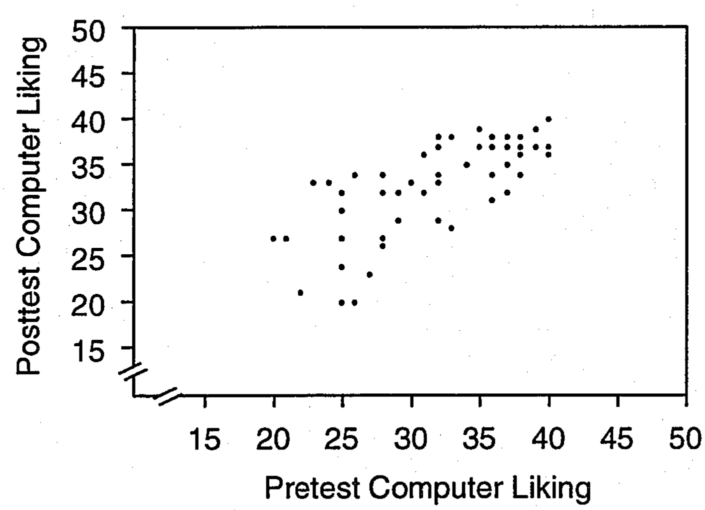


Figure 10. Scatterplot of posttest computer liking against pretest computer liking.

A Bartlett-Box $F$ test was used to test the assumption of homogeneity of variance. The results of the test did not lead

to the rejection of the null hypothesis that all population cell variances are equal, $F(3, 4697) = 1.40$, $p > .05$.

An ANOVA was conducted to test the assumption of homogeneity of regression. The null hypotheses tested were that the slopes of the regression lines were the same for all groups defined by treatment and by instructor. The Treatment x Pretest Computer Liking interaction, $F(1, 51) = 1.38$, and the Teacher x Pretest Computer Liking interaction, $F(1, 51) = 1.03$, were nonsignificant. Consequently there was insufficient evidence to reject the null hypotheses.

Table 47 is the ANCOVA table for posttest computer liking using pretest computer liking as the covariate.

Table 47

Analysis of Covariance for Posttest Computer Liking with Pretest Computer Liking as Covariate

| Source | df | F |
|---|---|---|
| Treatment | 1 | .50 |
| Course Instructor | 1 | .10 |
| Treatment x Course Instructor | 1 | .13 |
| Regression | 1 | 55.73* |
| Error | 52 | (13.09) |

Note. The value in the parentheses is the mean square error.

*$p < .001$.

There was insufficient evidence to reject the null hypotheses that there were no differences in mean posttest computer confidence between treatments and between groups taught by different instructors. Furthermore, the Treatment x Course Instructor interaction effect was nonsignificant. The null hypothesis that the common slope was 0 was rejected based on the significant regression effect.

Computer usefulness. Results of evaluation of the assumptions concerning extreme outliers and normality of the sampling distribution were unsatisfactory because of four extremely low pretest outliers and three extremely low posttest outliers. The outliers with their $z$ scores in parentheses were: (a) pretest computer usefulness outliers: 26 (-3.24), 27 (-2.93), 29 (-2.31), and 29 (-2.31); and (b) posttest computer usefulness outliers: 29 (-3.63), 30 (-3.21), and 30 (-3.21). Only one pretest outlier (26) was from the humanistically-focused treatment. Three pretest outliers (26, 29, and 29) were from groups taught by instructor number 2, all other pretest and all posttest outliers were from groups taught by instructor number 1. One case from the cognitively-focused treatment included both pretest and posttest outliers (scores of 27 and 29 respectively). In accordance with the procedures recommended by Tabachnick and Fidell (1989), the following actions were taken: (a) the single case with extreme pretest and posttest scores was

deleted from further analysis, and (b) the extreme scores of the remaining five cases were altered to bring them to within three box-lengths of the lower edge of the boxplot (i.e., extreme pretest scores were raised to 30 and extreme posttest scores were raised to 32).

The assumption of linearity between the pretest computer usefulness covariate and posttest computer usefulness was satisfied by visual inspection of the scatterplot illustrated in Figure 11.

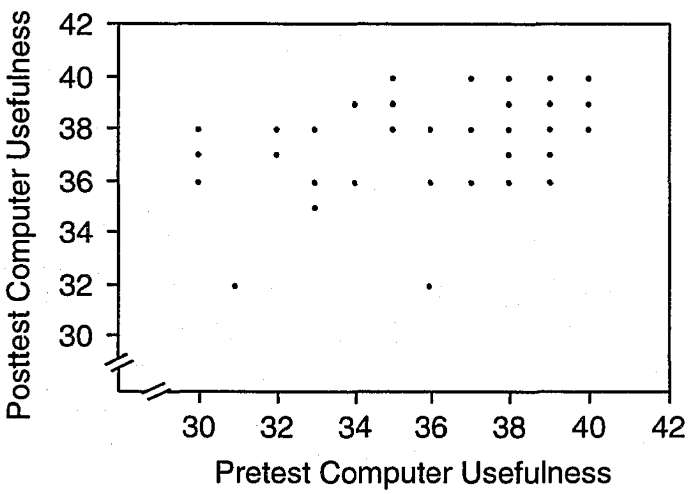


Figure 11. Scatterplot of posttest computer usefulness against pretest computer usefulness.

A Bartlett-Box $F$ test was used to test the assumption of homogeneity of variance. The results of the test did not lead to the rejection of the null hypothesis that all population cell variances are equal, $F(3, 4475) = 1.99$, $p > .05$.

An ANOVA was conducted to test the assumption of homogeneity of regression. The Treatment x Pretest Computer

Usefulness interaction, $F(1, 50) = 4.11$, $p < .05$, was significant and the Course Instructor x Pretest Computer Usefulness interaction, $F(1, 50) = 3.28$, was nonsignificant. Consequently the null hypothesis for the Treatment Pretest Computer Usefulness interaction was rejected but there was insufficient evidence to reject the null hypotheses for the Course Instructor x Pretest Computer Usefulness interaction. As a result, the ANCOVA model used in this analysis was fitted with separate slopes for each group.

Table 48 is the ANCOVA table for posttest computer usefulness using the pretest score as the covariate.

Table 48

Analysis of Covariance for Posttest Computer Usefulness with Pretest Computer Usefulness as Covariate

| Source | df | F |
|---|---|---|
| Treatment | 1 | 7.09* |
| Course Instructor | 1 | .02 |
| Treatment x Course Instructor | 1 | 1.67 |
| Regression | 1 | 18.41** |
| Error | 51 | (2.50) |

Note. The value in the parentheses is the mean square error.
$^*p < .01$. $^{**}p < .001$.

The null hypothesis that there was no difference in mean posttest computer usefulness between treatments was rejected

based on the significant treatment effect. There was insufficient evidence to reject the null hypotheses that there were no differences in mean posttest computer usefulness between groups taught by different course instructors and that there was no interaction effect based on the nonsignificant Treatment x Course Instructor effects. The null hypothesis that the slopes for each group were 0 was rejected based on the significant regression effect.

Table 49 displays the observed and adjusted posttest computer usefulness mean scores by course instructor and by treatment type.

Table 49

Observed and Adjusted Posttest Computer Usefulness Means by Cell

| | | M | |
|---|---|---|---|
| Instructor | Treatment | Observed | Adjusted |
| 1 | Cognitive | 37.33 | 37.08 |
| 1 | Humanistic | 38.64 | 38.80 |
| 2 | Cognitive | 37.50 | 37.59 |
| 2 | Humanistic | 38.18 | 38.18 |

Course evaluation. Groups taught by different course instructors were also assessed on how each group evaluated the course and the instructor. In accordance with university

policy, all ECI 304 students were afforded the opportunity to complete a course evaluation form anonymously at the end of the spring 1996 semester. The seven pertinent questions used in this evaluation are listed in Appendix K.

Data screening revealed that the means and standard deviations of student responses to each question were plausible, no out-of-range values were identified, and no data were missing. Results of evaluation of the assumptions concerning the absence of extreme outliers and normality of the sampling distributions were unsatisfactory. Boxplots identified a single case with five low outliers, three of which were extremelt low outliers, for the course evaluation of the humanistic treatment taught by instructor number 2. This case was deleted from the analysis because of the extremely negative evaluations in accordance with the procedure recommended by Tabachnick and Fidell (1989). A reevaluation of the assumption of normality of sampling distributions after deletion of the single case was satisfactory.

The results of student course evaluations are summarized in Table 50. Shown are the means and standard deviations of student responses to each of the seven questions contained on the course evaluation form for each instructor by treatment type.

Table 50

Student Responses to Course Evaluation Questions by Treatment Type and by Instructor

| | Cognitively-focused[a] | | | | Humanistically-focused[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | 1[c] | | 2[d] | | 1[e] | | 2[f] | |
| Question number | M | SD | M | SD | M | SD | M | SD |
| 1. | 5.13 | 1.20 | 4.80 | 1.08 | 4.93 | 1.44 | 4.00 | 1.04 |
| 2. | 5.31 | 1.09 | 4.73 | 1.16 | 4.86 | 1.40 | 3.71 | 1.14 |
| 3. | 5.34 | 1.02 | 5.60 | .63 | 4.71 | 1.68 | 5.29 | .91 |
| 4. | 5.13 | 1.20 | 5.40 | 1.12 | 5.00 | 1.57 | 4.07 | 1.90 |
| 5. | 4.88 | 1.15 | 4.67 | 1.30 | 5.00 | 1.47 | 3.79 | 1.25 |
| 6. | 5.25 | .93 | 4.93 | 1.16 | 5.00 | 1.41 | 4.36 | 1.01 |
| 7. | 5.13 | 1.26 | 5.27 | .88 | 4.71 | 1.68 | 4.21 | 1.25 |

Note. Responses were based on a 6-point scale (1 = unacceptable, 2 = poor, 3 = acceptable, 4 = good, 5 = very good, and 6 = excellent).

[a]N = 31. [b]N = 28. [c]n = 16. [d]n = 15. [e]n = 14. [f]n = 14.

A 2 x 2 MANOVA was conducted to determine how the subjects rated the course by teacher and by treatment type. The independent variables were group instructor (two levels: instructor number 1 and instructor number 2) and type treatment (two levels: cognitively-focused treatment and humanistically-focused treatment). The seven dependent

variables were student evaluations in response to each of the seven questions contained on the course evaluation form (see Appendix K).

Results of evaluation of the assumptions of multivariate normality, linearity, and multicollinearity were also satisfactory. However, the assumption of homogeneity of variance-covariance matrices was not tenable based on the unequal sample sizes and the significance of Box's M test, $M = 126.98$, $F(56, 4916) = 1.71$, $p < .001$. Since cells with smaller sample sizes produced larger variances, use of Wilks's λ to evaluate multivariate significance is too liberal. Accordingly, Pillai's criterion was used instead of Wilks's λ because it is robust to violations and is recommended by Tabachnick and Fidell (1989) given the circumstances that were encountered.

Pillai's criterion showed that the combined dependent variables were significantly affected by group instructor, $F(7, 49) = 4.93$, $p < .001$, but not by treatment type, $F(7, 49) = 1.35$, $p > .05$. Additionally, the Instructor x Treatment interaction was not significant, $F(7, 49) = 1.75$, $p > .05$.

To identify the dependent variable(s) on which the groups taught by different instructors differed, seven univariate F tests were performed, one for each of the seven questions. These tests showed significance for the following two questions:

1. Question number 2, "Rate the instructor's ability to communicate ideas effectively," $F(1, 57) = 7.59$, $p < .01$.

2. Question number 5, "Rate the overall quality of the course," $F(1, 57) = 4.48$, $p < .05$.

# CHAPTER V

# FINDINGS AND INTERPRETATIONS

## Introduction

Chapter V consists of: (a) a summary of the significant findings of this study, (b) a discussion and interpretation of the results of the pilot study and the main study, (c) a description of the implications of study findings, and (d) directions for further research.

## Summary

Purpose. The purpose of this three-part study was to: (a) determine how a computer literacy course affected the computer anxiety and computer attitudes of urban teacher education students over time; (b) explain and predict urban teacher education students who are resistant to reduction of computer anxiety; and (c) determine whether or not a humanistically-focused computer literacy course, that incorporates both cognitive and affective learning outcomes, is more effective than a more traditional cognitively-focused course in reducing computer anxiety and improving computer attitudes.

Pilot study. The pilot study yielded evidence that computer anxiety affects many teacher education students, affirmed the reliability of test instruments, and provided evidence to proceed with the main study with minor refinements. These refinements were designed to: (a) modify

procedures to increase the volunteer rate and decrease the mortality rate, (b) simplify test administration procedures, and (c) clarify specific items on the locally developed questionnaires.

Main study. A quasi-experimental design was used to determine how a computer literacy course affected computer anxiety and computer attitudes over time. Repeated measurements of computer anxiety, computer confidence, computer liking, and computer usefulness were collected over three observations using a 13-week interval. Seventy-five subjects were exposed to the treatment during the fall 1995 semester between the first and second observations. Repeated measures ANOVAs were used to assess patterns of stability and change in computer anxiety and attitudes about computers in order to assess immediate and delayed treatment effects.

The between subjects effects were all significant, thus confirming the expectation that the sample was heterogeneous with regard to each dependent variable (see Tables 16, 18, 20, and 21). For the within subjects effects, a significant reduction in computer anxiety means, $F(1.63, 120.60) = 36.32$ (see Table 16), and a significant increase in computer confidence means, $F(1.56, 115.47) = 11.11$ (see Table 18), $ps < .001$, were found across all three observations. Differences in computer liking and computer usefulness means were nonsignificant (see Tables 20 and 21). Trend analysis using

orthogonal polynomial contrasts revealed that the relationship between computer anxiety and the three observations was 94.75% linear and only 5.25% quadratic, and the relationship between computer confidence and the three observations was linear with a nonsignificant quadratic trend.

Not expected was the finding arising from a one-way ANCOVA that showed posttest computer anxiety levels varied significantly by course instructor after adjusting for differences in pretest computer anxiety levels, $F(3, 81) = 4.31$, $p < .05$ (see Table 23). A possible explanation for this finding is that the subjects taught by the two instructors whose students experienced the largest decrease in computer anxiety viewed their treatment experiences as positive and the students taught by the two instructors whose students experienced no significant reductions in computer anxiety viewed their experiences as less positive or negative. However, analyses performed to test this hypothesis based on course evaluations by students produced mixed results.

Multiple regression procedures were used for the second part of this study to explain and to predict posttest computer anxiety in 86 fall 1995 semester subjects at the completion of a computer literacy course. The predictor variables were pretest locus of control and trait anxiety and posttest computer confidence, computer experience, computer

knowledge, computer liking, and computer usefulness. Locus of control and trait anxiety were measured at the pretest observation instead of the posttest observation in order to help balance the time needed to measure variables at each observation. The impact of measuring locus of control and trait anxiety at the pretest observation instead of the posttest observation was considered negligible because these variables measure trait characteristics that are not expected to vary significantly over an individual's lifetime (Gaudry & Spielberger, 1971; Rotter, 1966).

The results of the regression analysis revealed that 69% of the variance in posttest computer anxiety could be explained by the combined influence of computer confidence, computer knowledge, computer liking, and trait anxiety (see Table 30). The addition of computer experience, computer usefulness, and locus of control to explain the variance in posttest computer anxiety was nonsignificant. The resulting regression equation was validated using 57 subjects who attended either cognitively-focused or humanistically-focused computer literacy courses during the spring 1996 semester. The shrinkage between the coefficient of multiple determination, $R^2$, for the fall 1995 semester sample and the estimated $R^2$ for the spring 1996 semester sample was .05. This low shrinkage and the significance of the resulting estimated $R^2$ of .64 affirmed the ability of computer confidence,

computer knowledge, computer liking, and trait anxiety to reliably predict posttest computer anxiety in new groups of teacher education students at the completion of computer literacy courses. A new regression analysis using a combined sample consisting of both fall 1995 semester and spring 1996 semester samples ($N$ = 143) resulted in a more parsimonious regression solution in which 69% of the variance in posttest computer anxiety could be explained by the combined influence of computer confidence, computer knowledge, and trait anxiety (see Table 34). Computer liking was eliminated as a significant predictor.

The final part of this study employed a quasi-experimental pretest-posttest comparison group design to determine differences in computer anxiety and attitudes about computers by treatment type and by course instructor using 57 spring 1996 semester subjects. Two instructors each taught one cognitively-focused treatment and one humanistically-focused treatment. Univariate ANCOVAs were conducted for posttest computer anxiety, computer confidence, computer liking, and computer usefulness using the appropriate pretest score as the covariate. A significant increase in computer usefulness means was found in the humanistically-focused treatment group, $F(1, 51) = 7.09$, $p < .01$ (see Table 48). Although both treatments were effective in reducing computer anxiety and increasing computer confidence, no significant

differences between treatments were found for computer anxiety, computer confidence, and computer liking, and no differences were found between course instructors.

## Pilot Study Discussion

### Introduction

The pilot study yielded evidence that computer anxiety affects many teacher education students, affirmed the reliability of test instruments, and provided evidence to proceed with the main study with minor refinements. These refinements were designed to: (a) modify procedures to increase the volunteer rate and decrease the mortality rate, (b) simplify test administration procedures, and (c) clarify items on the two locally developed questionnaires.

### Sample

Out of a sample consisting of 47 volunteers from the summer 1995 semester, 33 subjects (70.2%) were females and 14 subjects (29.8%) were males. Most subjects were seniors and graduate students (63.8%). The average age was 26.04 years (SD = 8.51).

The equivalence of the sample used in the pilot study to the two samples used in the main study was diminished because of the relatively large percentage of graduate students in the pilot study. Graduate students comprised 15 subjects (31.9%) out of the pilot study sample, seven subjects (7.6%) out of the main study fall 1995 semester sample, and five

subjects (8.0%) out of the main study spring 1996 semester sample. Although the equivalence of samples was diminished, the researcher assessed that the limited objectives of the pilot study were not compromised.

Volunteers and Dropouts

The volunteer rate for the pilot study was 85.5%. Eleven subjects dropped out of the study at the posttest observation for a dropout or mortality rate of 23.4%.

As a result of the pilot study the following actions were taken in the main study to help achieve a high volunteer rate and a low mortality rate: (a) course instructors were asked to endorse participation in the study, (b) nonvolunteers were required to work in the classroom on assignments provided by the course instructor, and (c) the subject orientation briefing (see Appendix A) was revised.

Revisions to the briefing consisted of the addition of the following information: (a) the time to complete all questionnaires should be less than 20 minutes, (b) prior computer knowledge and experience were not required to participate in the study, and (c) local addresses were requested only from subjects taking ECI 304 during the fall 1995 semester in order for the researcher to mail the delayed observation test instruments to subjects in March 1996.

No significant differences were found on demographic variables between volunteers ($N$ = 47) and nonvolunteers who

agreed to complete the Start-of-Study Questionnaire anonymously ($\underline{N}$ = 4). Additionally, no significant differences were found between subjects who completed the study ($\underline{N}$ = 36) and dropouts ($\underline{N}$ = 11) on demographic variables and pretest computer anxiety, computer confidence, computer usefulness, and computer liking. Consequently there was no evidence of bias between volunteers and nonvolunteers and between dropouts and nondropouts.

Computer Anxiety Scores

The COMPAS long form, which consists of both parallel forms administered together, was used to measure computer anxiety during the pilot study in order to determine if the parallel forms were equivalent as claimed in the test manual (Oetting, 1983). COMPAS parallel forms were used to measure computer anxiety during the main study in order to help control for test familiarity because of the repeated administrations of the test instrument. Consequently pilot study and main study computer anxiety scores can be compared only if the pilot study scores are halved or the main study scores are doubled.

The overall mean pretest computer anxiety score was 100.86 ($\underline{SD}$ = 36.14), with females scoring 105.64 (SD = 34.80) and males scoring 89.93 ($\underline{SD}$ = 25.36). The difference in mean computer anxiety scores between females and males was a surprise since studies have found no significant correlation

between sex and computer anxiety (Hunt & Bohlin, 1991; Gordon, 1993). However, this difference was not reflected in main study subjects.

At the pretest observation, 27.7% of subjects scored at or above the mild computer anxiety level (a score of 120), 12.8% of subjects scored at or above the computer anxious/tense level (a score of 140), and 4.3% of subjects scored at the very computer anxious level (a score of 160) (see Table 6). The percentages are considerably higher than the percentages reporting by Oetting (1983) in the COMPAS normative study that measured 482 entering freshmen at Colorado State University, e.g., Oetting reported only 16.8% of normative study subjects scored at or above the mild computer anxiety level (see Table 6). These results provide evidence that computer anxiety affects many teacher education students.

Thirty-two subjects (68.1%) reported that they owned a personal computer. The mean pretest computer anxiety score for subjects who owned computers was 91.78 ($SD$ = 32.82) and 120.53 ($SD$ = 32.12) for subjects who did not own computers. The mean posttest computer anxiety score for computer owners was 84.63 ($SD$ = 35.24) and 111.00 ($SD$ = 32.12) for subjects who did not own computers. These results show that computer owners were less computer anxious than subjects who did not own computers at the start of the treatment and this

difference remained mostly intact at the end of the treatment although the levels of computer anxiety were diminished in both groups.

There was a statistically significant drop between mean computer anxiety pretest and posttest scores at the .10 level of significance, but not at the expected .05 significance level (see Table 7). This finding was surprising since Howard's (1986) theory suggests a treatment that provides computer knowledge and experience can significantly reduce computer anxiety. The literature review contained references to many studies that found significance at the .05 level (Honeyman and White, 1987; Overbaugh, 1993; Rosen, Sears, & Weil, 1993; Savenye, Davidson, & Orr, 1992; Torris, 1985). It is possible that the relatively short four week duration of the treatment contributed to this finding.

Test Administration Procedures

As a result of the analysis of subject feedback, question number 11 of the Start-of-Study Questionnaire was changed from "Typically, how many total hours per week during the school year do you use a computer at school and at home" to "Typically, how many total hours per week during the school year do you use a computer at school, at work, and at home." Question number 12 was similarly changed. These changes were designed to reduce ambiguity and to provide for

a more accurate measurement of computer experience by the Computer Experience Scale.

Scale Reliability

The reliabilities of the standardized instruments used in the study were checked and found to be consistent with prior reports of instrument reliability. Additionally, the two locally developed scales, the Computer Experience Scale and the Computer Knowledge Scale, demonstrated reliabilities that were adequate for their use in the main study (see Tables 1 and 4). In particular, the .90 coefficient of internal consistency and the .77 coefficient of stability obtained for the Computer Knowledge Scale were respectable.

Equivalence of the two COMPAS parallel forms was also demonstrated by showing that the means of scores obtained from both forms for each observation were similar (see Table 3). Equivalence of the COMPAS parallel forms was important for two reasons. First, observed COMPAS scores were interpreted in the main study rather than making use of percentile norms. Secondly, in order to control for test familiarity, subjects were administered COMPAS parallel form A or parallel form B at each testing session in order to measure computer anxiety.

Computer Anxiety Stimuli

The plan for this study included the control of the presence of computers during all main study observations of

computer anxiety with the exception of the delayed test observation for research question number 1. For the delayed test observation the plan was for subjects to receive the COMPAS by mail as part of the delayed observation test battery (see Table 2) and to complete it in an uncontrolled environment of their choice. The rationale for this procedure was to avoid the high study mortality that could occur if subjects were required to return to the educational computer laboratory where all other observations were conducted 13 weeks after completing the treatment for administration of the COMPAS in a controlled environment. Evidence to support this view was the relatively high 23.4% subject mortality rate experienced during the pilot study when all observations were conducted during regularly scheduled class meetings. Also, postobservation discussions with pilot study subjects provided verbal evidence that few of them would return for a delayed test observation unless a very strong incentive was provided.

If evidence was found that the presence of computers influenced COMPAS measurements of computer anxiety, then there would be a need to conduct the delayed test observation in a controlled environment. The COMPAS test manual (Oetting, 1983) does not address this issue although both Gaudry and Spielberger (1971) and Howard (1986) contend that an external stimulus is required for state anxiety to manifest itself.

Consequently an objective of the pilot study was to determine if the presence of computers affected COMPAS measurements of computer anxiety.

ANOVA results provided evidence that measurements of computer anxiety were not affected by the absence, presence, or use of a computer (see Table 5). As a result of this finding the use of the mail for the delayed test observation of research question number 1 was confirmed.

Multiple Regression Analysis

The purpose of research question number 2 was to explain and to predict computer anxiety at the end of a computer literacy course. The pilot study was used to conduct an analysis of this question using multiple regression in order to provide preliminary insights and to help determine if the research question should be accepted as stated, refined, or dropped altogether from the main study.

Computer anxiety measured at the posttest observation was the criterion variable, and the predictor variables were pretest locus of control and trait anxiety and posttest computer confidence, computer experience, computer knowledge, computer liking, and computer usefulness. The rationale was that, taken as a group, the most significant predictors of computer anxiety at the end of a computer literacy course should consist of variables that are related to the source of computer anxiety that is the most difficult to successfully

treat, which Howard (1986) identified as psychological makeup.

The multiple regression analysis identified the attitudes of computer confidence and computer liking, $F(2, 33) = 85.10$, $p < .0001$ (see Tables 9 and 10) as significant predictors of computer anxiety. Taken together, computer confidence and computer liking accounted for 84% of the variance of computer anxiety at the end of the treatment. Between these two variables, computer confidence, $\beta = -.54$, was a stronger predictor than computer liking, $\beta = -.42$.

Surprisingly, trait anxiety, which Howard (1986) asserted is a characteristic of many individuals who are resistant to reduction of computer anxiety and which is not readily treatable, was not a significant predictor of posttest computer anxiety. A possible explanation is that the pilot study sample was not a typical sample because subjects were not selected randomly and trait anxiety may not have been an important source of computer anxiety in pilot study subjects. A check of trait anxiety mean scores provided a measure of support for this explanation. The mean trait anxiety scores were 35.70 ($SD = 7.27$) for the pilot study, 38.44 ($SD = 9.52$) for the fall 1995 semester sample, and 38.05 ($SD = 7.63$) for the spring 1996 semester sample. Additionally, Spielberger (1983) reported that the normative trait anxiety mean score for male college students was 38.30

(SD = 9.18, N = 324) and 40.40 (SD = 10.15, N = 531) for female college students.

Despite the fact that trait anxiety was not a reliable predictor of posttest computer anxiety in pilot study subjects, the results of the multiple regression analysis are generally consistent with Howard's theory of computer anxiety because attitudes are related to the psychological makeup of individuals which Howard identified as the most difficult source of computer anxiety to treat.

The pilot study provided evidence to proceed with research question number 2 in the main study without change.

## Main Study Discussion

### Research question number 1

Question. What effect does a computer literacy course have on the computer anxiety and computer attitudes of urban teacher education students over three observations at 13-week intervals?

Hypothesis. The hypotheses tested in this study were that the sample was heterogeneous with regard to each dependent variable (between subjects effects) and a computer literacy course would result in lower computer anxiety and improved attitudes of computer confidence, computer liking, and computer usefulness at treatment termination and these gains would be maintained 13 weeks later (within subjects effects).

Sample. Ninety-three fall 1995 semester subjects volunteered to participate in this study for a 92.10% volunteer rate. However, the researcher removed one subject from the study because of an extremely negative attitude about the usefulness of computers.

Out of the 92 subjects who started the study, six subjects dropped out of the study at the posttest observation and 11 subjects dropped out of the study at the delayed test observation resulting in a total dropout or mortality rate of 18.48%. The mortality rate was not considered a serious threat to the validity of this study because no evidence of bias was found between dropouts and nondropouts on variables measured at the pretest observation (see Table 11). Furthermore, most of the dropouts occurred at the delayed test observation in which a nonresponding rate of 11.96% was obtained. For mailed questionnaires, Borg and Gall (1989) assert that a nonresponding rate of less than 20% usually presents no serious threat of bias.

Subject demographic data held no surprises. The predominant sex was female (73.9%), the average age was 23.61 years (SD = 5.33), and most subjects were juniors (50%).

The overall mean pretest computer anxiety score was 53.49 (SD = 15.12) (see Table 13), with females scoring 53.53 (SD = 16.24) and males scoring 53.38 (SD = 11.69).

At the pretest observation, 30.4% of subjects scored at or above the mild computer anxiety level (a score of 60), 18.5% of subjects scored at or above the computer anxious/tense level (a score of 70), and 3.3% of subjects scored at the very computer anxious level (a score of 80) (see Table 14). These scores are considerably higher than the scores reported by Oetting (1983) in the COMPAS normative study that measured 482 entering freshmen at Colorado State University. For the normative study, 16.8% of subjects scored at or above the mild computer anxiety level, 6.4% of subjects scored at or above the computer anxious/tense level, and 2.1% of subjects scored at the very computer anxious level. These results provide evidence that computer anxiety affects many teacher education students.

As expected, the percentage of subjects manifesting measurable levels of computer anxiety was lower at the posttest and delayed test observations. Only 14.0% scored at or above the mild computer anxiety level at the posttest observation and only 9.3% scored at or above this level at the delayed test observation.

Sixty-three subjects (68.5%) reported that they owned a personal computer. The mean pretest computer anxiety score for subjects who owned computers was 51.25 (SD = 14.15) and 58.35 (SD = 16.24) for subjects who did not own computers. The mean posttest computer anxiety score for computer owners

was 46.10 (SD = 10.55) and 48.36 (SD = 12.07) for subjects who did not own computers. These results show that computer owners were less computer anxious than subjects who did not own computers at the start of the treatment. In contrast to the pilot study sample, the computer anxiety differences between groups narrowed considerably at the posttest observation.

Assumptions. The assumption of no extreme outliers was not tenable for computer usefulness. A boxplot was used to identify a computer usefulness score ($z$ = -5.19) that was more than 3 box-lengths below the lower edge of the box. Additionally, this subject's computer experience and computer liking scores were between 1.5 and 3 box-lengths below the lower edge of the respective boxes. Consequently the researcher removed this subject from the study.

The assumption of normality of the distribution of residuals was verified by an examination of residuals scatterplots.

There was no reason to suspect the assumption of independence of observations between subjects. The procedures specified by test instrument authors were followed in the administration of the CAS and the COMPAS (Gressard & Loyd, 1985; Oetting, 1983). Specifically, each subject was administered the test battery independently and no opportunity was provided during the pretest and posttest

observations for subjects to discuss their responses. For the delayed test observation which was administered in an uncontrolled environment, subjects were directed to respond honestly and independently to each questionnaire item (see Appendix J).

The assumption of sphericity (variances of differences between pairs of repeated measure factor levels are equal) was not tenable for both computer anxiety and computer confidence data. When the sphericity assumption is violated, $\alpha$ is greater than p. Consequently the degrees of freedom used to calculate the within subjects effects were adjusted to compensate for the departure of sphericity using the Hunh-Feldt $\varepsilon$ (a measure that reflects the amount of departure from the sphericity assumption) as recommended by Glass and Hopkins (1996).

The assumption of symmetry (the variance-covariance matrix of the transformed variables used to test the effect has covariances of 0 and equal variances) was not tested because "these conditions (symmetry) are sufficient to give correct probability statements in repeated measures designs, but in recent years have been shown to be more restrictive than necessary" (Glass & Hopkins, 1996, p. 575). The test of sphericity and the adjusted degrees of freedom for departures from sphericity are sufficient for the repeated measures

ANOVA to yield an accurate F ratio (Girden, 1992; Glass & Hopkins, 1996).

Between subjects effects. Since the treatment was a mandatory course in Old Dominion University's teacher education program, the expectation was that the subjects were a heterogeneous group with regard to each dependent variable. The null hypothesis that there were no differences among subjects ($N = 75$) was rejected for: (a) computer anxiety, $F(1, 74) = 1451.33$ (see Table 16); (b) computer confidence, $F(1, 74) = 3888.72$ (see Table 18); (c) computer liking, $F(1, 74) = 3912.41$ (see Table 20); and (d) computer usefulness, $F(1, 74) = 23967.92$ (see Table 21), $ps < .001$. This finding provided evidence that the levels of computer anxiety, computer confidence, computer liking, and computer usefulness differed significantly between subjects.

Immediate within subjects effects. The significant reduction of computer anxiety means, $F(1.63, 120.60) = 36.32$ (see Table 16), and the significant improvement of computer confidence means, $F(1.56, 115.47) = 11.11$ (see Table 18), $ps < .001$, resulting from the repeated measures ANOVAs were expected and are consistent with previous research (Honeyman and White, 1987; Overbaugh, 1993; Rosen, Sears, & Weil, 1993; Savenye, Davidson, & Orr, 1992; Torris, 1985). The fractional df included in the results are the result of the Hunh-Feldt

adjustment to compensate for departures from the sphericity assumption.

Less expected was the absence of a concurrent significant improvement in the attitudes of computer liking, $F(2, 148) = .09$, MSE = 7.92 (see Table 20), and computer usefulness, $F(2, 148) = .52$, MSE = 4.03 (see Table 21). There are three possible explanations for these results: (a) the treatments, as presented during the fall 1995 semester, lacked any planned affective learning outcomes aimed at improving the attitudes of computer liking and computer usefulness; (b) attitudes are difficult to change (Howard, 1986) and the treatments were not effective in this regard; and (c) the attitude of computer usefulness was not significantly improved because subjects were unable to visualize how the computer knowledge and skills they acquired during the treatments could benefit them as classroom teachers. The only evidence to support this last point consisted of comments recorded by three subjects on the End-of-Study Questionnaire that treatment expectations were only satisfied in part because the course focused on the acquisition of basic computer skills and more instruction was needed on the educational uses of computers.

Computer confidence, an attitude that was significantly improved at the posttest observation (see Table 25), is related to factors that were addressed by the treatments: (a)

anxiety reduction and performance accomplishments (Bandura, 1977, 1982; Schunk, 1985, 1989), and (b) computer experience (Koohang, 1986, 1989; Gardner, Discenza, & Dukes, 1993). However, in this study Pearson $r$ correlations between computer confidence and computer experience ranged from .24 to .54 and thus revealed only a low to moderate relationship between these variables (see Tables 8, 12, 29, 33 and 37).

Delayed within subjects effects. Trend analysis, using orthogonal polynomial contrasts, provided information regarding the delayed effects of computer anxiety and computer confidence means across the three observations. Orthogonal polynomial contrasts used the same assumptions as repeated measures ANOVAs with the exception that no assumption of sphericity was required. Consequently all assumptions were tenable.

A noteworthy finding, based on the significant linear polynomial contrasts for computer anxiety, $F(1, 74) = 48.72$ (see Table 17), and computer confidence, $F(1, 74) = 17.04$ (see Table 19), $ps < .001$, was that the significant improvements made in the reduction of computer anxiety and the increase of computer confidence between the pretest and posttest observations continued to improve along significant linear trend lines after the posttest observation.

The significant quadratic polynomial contrast for computer anxiety, $F(1, 74) = 6.49$, $p < .05$ (see Table 16),

indicated that the rate of computer anxiety reduction between the posttest and delayed test observations was less than between the pretest and posttest observations. However, the overall trend across the three observations was predominately linear as the linear SS accounted for 94.75% of variability among the three computer anxiety means and the quadratic SS accounted for only 5.25% of the variability. In other words, the overall reduction of computer anxiety across all three observations was sustained at a significant level. Figure 1 provides a graphical representation of this linear trend with the small single bend representing the quadratic component of the overall trend.

The absence of any significant quadratic polynomial contrast for computer confidence, $F(1, 74) = .03$, $MSE = 5.83$ (see Table 19), provided evidence that the rate of computer confidence improvement between the posttest and delayed test observations was similar to the rate of improvement between the pretest and posttest observations. That is, the overall trend of computer confidence means across the three observations was sustained at a nearly constant rate. The computer confidence graph in Figure 2 displays this strong linear trend.

An additional noteworthy finding was that the subjects reported significant increases in computer use after treatment completion over what they reported prior to

treatment start, $t(74) = 3.92$, $p < .001$. Continued reductions in computer anxiety levels and increases in computer confidence levels between the posttest and delayed test observations are consistent with increased computer use since significant Pearson $r$ correlations were found between computer experience and computer anxiety (with a range between -.27 and -.52) and between computer experience and computer confidence (with a range between .24 and .54) (see Tables 8, 12, 29, 33, and 37). However, this study provided no evidence of cause and effect. The increased computer use after treatment termination could be caused by lower levels of computer anxiety, lower levels of computer anxiety could be caused by increased computer usage, or other variables such as spring semester course requirements may be at work. The researcher believes lower levels of computer anxiety do lead to increased computer usage if computers are available, if individuals possess the requisite computer knowledge and skills, and if a requirement to use computers presents itself, such as the need to prepare papers.

Relationship to past longitudinal research. The findings for research question number 1 are broadly consistent with the longitudinal research of Rosen, Sears, and Weil (1993) who found that a university computer anxiety reduction program significantly reduced computer anxiety and the reduction was maintained six months after treatment

termination. However, major differences between the two studies were the treatment and the subjects. In this study the treatment was a semester-long computer literacy course required of all students in a predominately undergraduate teacher education program at Old Dominion University. The course provided computer knowledge and experience to a group that was heterogeneous with regard to pretest computer anxiety.

In the study by Rosen, Sears, and Weil (1993), the treatment was a specially developed intervention for computer anxious university students that consisted of two individualized treatment modules and one group treatment module that covered a 5-week period. The intervention was a psychologically-based program devoid of computer experience. The subjects in this program were homogeneous with regard to pretest computer anxiety, i.e., they were all computer anxious.

The reductions in computer anxiety found by both studies, given the substantial differences in treatments and subjects, provide evidence that there is no single efficacious approach to treating computer anxiety. However, while the benefits of the psychologically-based program were maintained at the delayed test observation, the benefits of the computer literacy treatments used in this study continued to accrue at significant levels between the posttest and

delayed test observations. These results suggest that a treatment should include computer knowledge and experience if treatment benefits are to continue to accrue beyond treatment termination. However, additional research is required to determine which treatment approach is more efficacious for treating computer anxious individuals who are resistant to reductions in computer anxiety.

Instructor effects. Not expected was the finding arising from a one-way ANCOVA that revealed posttest computer anxiety levels varied significantly by course instructor, $F(3, 81) = 4.31$, $p < .05$, after adjusting for differences in pretest computer anxiety levels, despite use of the same textbook, venue, and course length, and similar subjects and course content (see Table 23). Post hoc deviation contrasts provided evidence that the group taught by instructor number 1 scored significantly lower (i.e., better) than the overall computer anxiety effect, $t(3) = -2.85$, $p < .05$, and the group taught by instructor number 2 scored significantly higher (i.e., worse) than the overall computer anxiety effect, $t(3) = 2.55$, $p < .05$. Furthermore, the absence of a significant computer anxiety reduction in the group taught by instructor number 2 (see Table 22) runs counter to previous published research (Honeyman and White, 1987; Overbaugh, 1993; Rosen, Sears, & Weil, 1993; Savenye, Davidson, & Orr, 1992; Torris, 1985). The deviations from the overall computer anxiety effect

manifested by the groups taught by instructors number 3 and number 4 were nonsignificant, although a paired t test showed a significant computer anxiety reduction in the group taught by instructor number 3, $t(15) = -3.17$, $p < .01$ (see Table 22).

The work of Weil, Rosen, and Wugalter (1990) provides a possible explanation for these findings. They found that the benefits of computer experience depended on how the experience was interpreted by the individual. They assert that a positive experience is interpreted in a beneficial manner and can lead to reduced computer anxiety, while a less positive or negative experience with computers can lead to no reduction in computer anxiety or, in some cases, to even higher levels of computer anxiety. Accordingly, one can draw on this framework and postulate that the subjects taught by instructor number 1 interpreted their computer experiences as more positive than the students taught by instructor number 2 because the computer anxiety levels of students taught by instructor number 1 were significantly reduced and those taught by instructor number 2 were not.

Results of student course evaluations provide some evidence to support this view if one assumes that student course evaluations are directly related to student interpretations of their course experiences (i.e., higher student course evaluations are related to more positive

student experiences and less positive student course evaluations are related to less positive student experiences). A MANOVA was used to determine if the four groups taught by different instructors evaluated the treatment differently. All MANOVA assumptions were tenable with the exception of the assumption of homogeneity of variance-covariance matrices (the multivariate generalization of the homogeneity of variance assumption) based on the results of Box's $M$ test, $F(84, 5827) = 1.65$, $p < .001$. Accordingly, Pillai's criterion was used instead of Wilks's $\lambda$ because it is robust to violations of the assumption of homogeneity of variance-covariance matrices (Tabachnick & Fidell, 1989).

The MANOVA using Pillai's criterion showed that the combined evaluations of student responses to seven questions on the course evaluation questionnaire (see Appendix K) were significantly affected by the group instructor, $F(21, 243) = 3.01$, $p < .001$. Post hoc ANOVAs provided evidence that the students taught by instructor number 1 evaluated their course significantly higher than the overall student evaluations on "instructor's ability to communicate ideas effectively," $t(3) = 2.74$, $p < .05$, and "instructor's consistency/punctuality meeting class & using allotted time," $t(3) = 2.62$, $p < .05$. On the other hand, the students taught by instructor number 2 evaluated their course significantly lower than the overall

course evaluation on "instructor's consistency/punctuality meeting class & using allotted time," $t(3) = -5.45$, $p < .001$.

However, these results need to be viewed with caution as "instructor's consistency/punctuality meeting class & using allotted time," the only question in which the evaluation of the treatment taught by instructor number 2 was significantly below the overall mean, does not appear important enough nor does the deviation from the mean appear great enough to create a negative course experience for students. The results of the evaluations of question number 1, "overall effectiveness of the instructor," and question number 5, "overall quality of the course," would appear to be more important in this regard. However, the treatments taught by instructors number 1 and number 2 received similar evaluations for these two questions (see Table 28). Furthermore, the treatment taught by instructor number 3, whose subjects achieved a significant reduction in computer anxiety, $t(15) = -3.17$, $p < .01$ (see Table 22), was evaluated lower, although not significantly so, for these two questions than was the treatment taught by instructor number 2 (see Table 28). Additionally, for the spring 1996 semester treatments, there was a significant reduction in computer anxiety and a significant increase in computer confidence in the groups taught by the two instructors (see Table 50), regardless of the finding that the two instructors differed

significantly on student course evaluations. Clearly, more research is needed before any conclusions can be reached to fully explain instructor effects.

Research question number 2

Question. Which variables make the best predictors of the retained computer anxiety of urban teacher education students at the end of a computer literacy course and what optimum weight should be associated with each predictor?

Hypothesis. The hypothesis tested was that computer experience, computer knowledge, locus of control, trait anxiety, and the attitudes of computer confidence, computer liking, and computer usefulness provide significant contributions to the prediction of computer anxiety of urban teacher education students at the end of a computer literacy course.

Sample. Eighty-six subjects from the fall 1995 semester sample were used for this analysis. These were the same subjects who completed the pretest and posttest observations for research question number 1 and represent a 92.10% volunteer rate and a 6.52% mortality rate.

Tabachnick and Fidell (1989) state that the ratio of cases to predictor variables in a multiple regression analysis must be substantial, and a bare minimum requirement is to have at least 5 times more subjects than predictor variables. Using this criterion, the bare minimum number of

subjects needed for this analysis was 35. Since 86 cases were used, the bare minimum criterion was exceeded by a comfortable margin.

Selection and measurement of predictors. Howard (1986) identified three sources of computer anxiety: (a) lack of operational experience with computers; (b) inadequate knowledge about computers; and (c) psychological makeup. He theorized that computer anxiety that is based on the lack of operational experience with computers is the easiest to treat, computer anxiety arising from knowledge-based origins is of intermediate difficulty to treat, and computer anxiety that is based on an individual's psychological makeup is the most difficult to treat. The predictors selected for this analysis address all three sources of computer anxiety. If Howard's theory of computer anxiety is accurate, computer experience should be the least significant predictor of posttest computer anxiety because it is related to the easiest source of computer anxiety to treat and the treatment placed emphasis on providing computer experience. Computer knowledge should be a more significant predictor because it is more difficult to treat and the treatment provided limited computer knowledge (e.g., computer programming was not taught). Finally, predictors related to psychological makeup (i.e., locus of control, trait anxiety and the attitudes of computer confidence, computer liking, and computer

usefulness) as a group should be the strongest predictors because they addresses the most difficult source of computer anxiety to treat. Furthermore, there were no plans for the treatments to address the psychological makeup source of computer anxiety, although such uncontrolled factors as classroom discussions may have had an indirect impact.

All the predictor variables were measured at the posttest observation at the completion of the computer literacy course except for locus of control and trait anxiety which were measured at the pretest observation. Since locus of control and trait anxiety are trait characteristics that are unlikely to vary significantly during the course of an individual's lifetime (Gaudry & Spielberger, 1971; Rotter, 1966), they were measured at the pretest observation in order to help balance testing time between observations.

Regression analysis. The analysis conducted for this research question used ordinary least squares regression to provide evidence that computer confidence, computer knowledge, computer liking, and trait anxiety can reliably explain and predict posttest computer anxiety at the end of a computer literacy course for teacher education students (see Table 30). The relationship between the predictor variables and the criterion variable was highly significant, $F(4, 81) = 45.71$, $p < .0001$ (see Table 31), indicating that the observed relationship was not simply an unlikely chance occurrence.

Regression assumptions were tenable. Figure 7 demonstrated normality because it reveals a pileup of residuals in the center of the plot at most values of the predicted score, and a normal distribution of residuals trailing off symmetrically from the center. Figure 7 also demonstrated linearity because the shape of the scatterplot is approximately rectangular rather than curved. Finally, Figure 7 demonstrated homoscedasticity because the band enclosing the residuals is approximately equal in width at most values of predicted posttest computer anxiety.

An examination of the eigenvalues, condition indexes, and variance proportions of the scaled, uncentered cross-product matrices confirmed the absence of very high collinearity among the predictor variables (see Table 32). The fifth eigenvalue, which possessed the highest condition index, accounted for 95% of the variance of computer confidence and 74% of the variance of computer liking. For multicollinearity to be a problem, the variance proportions must account for over 90% of the variance of each predictor (Tabachnick & Fidell, 1989).

Since all multiple regression assumptions were tenable, the least squares predictors of the regression solution have several desirable properties, including unbiasedness and efficiency, and can be used for statistical inference such as

conducting tests of statistical significance or calculating confidence intervals (Berry & Feldman, 1985; Berry, 1993).

The multiple regression analysis yielded the following equation:

$$y' = 84.04 - .87x_1 - .51x_2 - .45x_3 + .33x_4$$

where y' is the predicted posttest computer anxiety score, $x_1$ is the computer confidence score, $x_2$ is the computer knowledge score, $x_3$ is the computer liking score, and $x_4$ is the trait anxiety score.

As expected, the best relative predictors of posttest computer anxiety were related to the psychological makeup source of computer anxiety. Computer confidence, $\beta = -.42$, was the strongest predictor followed by trait anxiety, $\beta = .28$, computer knowledge, $\beta = -.22$, and computer liking, $\beta = -.21$. Taken together, these variables accounted for 69% of the variance of posttest computer anxiety indicating a very substantial relationship. Computer experience, computer usefulness, and locus of control did not account for any significant additional variance.

These findings are consistent with Howard's (1986) theory of computer anxiety. Computer experience was probably not a significant predictor of posttest computer anxiety because the posttest observation took place at the end of

treatments that placed emphasis on computer experience, the easiest source of computer anxiety to treat according to Howard.

The inability of locus of control to reliably predict posttest computer anxiety can possibly be explained by a combination of the following factors: (a) locus of control and trait anxiety are related, $r = .38$; (b) trait anxiety is a significant predictor of posttest computer anxiety; and (c) the unique contribution of locus of control to predicting posttest computer anxiety was statistically insignificant.

Although computer usefulness was not a significant predictor of posttest computer anxiety, it was highly related to computer confidence, $r = .53$, and to computer liking, $r = .56$, which were significant predictors. As was the case with locus of control, the unique contribution of computer usefulness to predicting posttest computer anxiety was statistically insignificant.

Cross-validation. Cross-validation, as recommended by Pedhazur (1982), was conducted to determine the usefulness of the regression solution. The regression equation developed using fall 1995 semester subjects (screening sample) was used to predict posttest computer anxiety for spring 1996 semester subjects (calibration sample).

The Pearson $r$ (analogous to the multiple correlation coefficient $R$) between observed posttest computer anxiety and

predicted posttest computer anxiety revealed a substantial relationship within the spring 1996 semester sample, r = .80, resulting in an estimated $R^2$ equal to .64. Estimated shrinkage of $R^2$ between the fall 1995 semester sample and spring 1996 semester sample was small ($\Delta R^2 = -.05$). These results affirmed the ability of computer confidence, computer knowledge, computer liking, and trait anxiety to reliably predict posttest computer anxiety in new groups of teacher education students at the completion of an introductory computer literacy course.

As a consequence of the low shrinkage, the fall 1995 semester and spring 1996 semester samples were statistically combined to form a new sample (N = 143). This time the multiple regression model yielded a more parsimonious regression equation with three rather than four significant predictors of posttest computer anxiety (see Table 34). Computer liking, which was a significant predictor of posttest computer anxiety in the fall 1995 semester sample, was not a significant predictor in the new sample. This outcome was not entirely unexpected as Table 32 showed that the fifth eigenvalue accounted for 95% of the variance of computer confidence and 74% of the variance of computer liking. Without computer liking as a predictor, the beta weight of computer confidence increased from -.42 to -.62 in the regression analysis using the new sample.

The relationship between the three predictor variables and the criterion variable was highly significant, $\underline{F}(3, 139) = 103.99$, $\underline{p} < .0001$, (see Table 35) indicating that the observed relationship was not simply an unlikely chance occurrence.

The multiple regression analysis yielded the following equation:

$$y' = 83.93 - 1.34x_1 - .44x_2 + .33x_3$$

where y' is the predicted posttest computer anxiety score, $x_1$ is the computer confidence score, $x_2$ is the computer knowledge score, and $x_3$ is the trait anxiety score.

Computer confidence, $\beta = -.62$, was the strongest predictor of posttest computer anxiety followed by trait anxiety, $\beta = .26$, and computer knowledge, $\beta = -.22$. Taken together, these variables accounted for 69% of the variance of posttest computer anxiety.

These findings suggest that any efforts to treat retained computer anxiety in teacher education students at the completion of a computer literacy course should focus on building computer confidence and expanding students' knowledge about computers. Any efforts to treat trait anxiety would appear to be fruitless since trait anxiety is a trait characteristic that Gaudry and Spielberger (1971) assert is

unlikely to vary significantly during the course of an individual's lifetime.

Issues. The regression analysis used in this study revealed relationships between variables but cannot be used to imply that the relationships are causal because there was no random assignment as intact groups were used in this study. The purpose of research question number 2 was to explain and to predict, not to determine causality.

The magnitude of a predictor's beta weight should not be confused with its importance. The beta weight is dependent on such factors as the selection of predictors, the predictor's correlation with other predictors, and the order the predictors were entered into the multiple regression analysis.

Although the tenability of regression assumptions provides assurance that on average the least square predictors are on target (unbiasedness), no assurance is provided that an individual predictor will be on target in a specific sample.

Research question number 3

Question. How does a computer literacy course affect the computer anxiety and computer attitudes of urban teacher education students based on type of treatment and instructor?

Hypothesis. The hypotheses tested in this study were that a humanistically-focused treatment would result in lower

computer anxiety and improved attitudes of computer confidence, computer liking, and computer usefulness than a cognitively-focused treatment and differences in treatment effects would not vary by instructor.

Sample. Sixty-three spring 1996 semester students volunteered to participate in this study for a 92.65% volunteer rate. Six subjects dropped out of the study at the posttest observation resulting in a 9.52% mortality rate. Since dropouts were considered a possible source of bias, independent samples $t$ tests were conducted to determine if dropouts differed from nondropouts on variables measured at the pretest observation. Dropouts were found to possess more computer experience, $t(61) = 2.19$, more computer knowledge, $t(61) = 2.48$, and were more internally oriented, $t(61) = 2.09$, $ps < .05$, than nondropouts (see Table 36). This evidence of bias between dropouts and nondropouts was not a serious threat to the validity of the study because: (a) the number of dropouts ($n = 6$) was relatively low, (b) dropouts and nondropouts did not differ on any of the outcome variables analyzed for this research question, and (c) dropouts were evenly distributed between the cognitively-focused and humanistically-focused treatments.

Subject demographic data was similar to the fall 1995 semester sample with some differences: (a) fifty-three subjects (84.1%) were females in the spring 1996 semester

sample versus 73.9% in the fall 1995 semester sample, the average age was 24.65 years (SD = 7.27) versus 23.61 years (SD = 5.33), and most subjects were either sophomores or juniors (68.2%) versus juniors and seniors (76.1%).

The overall mean pretest computer anxiety score was 47.72 (SD = 15.53) (see Table 39), with females scoring 47.64 (SD = 17.01) and males scoring 49.10 (SD = 11.36).

At the pretest observation, 23.8% of subjects (versus 30.4% for the fall 1995 sample) scored at or above the mild computer anxiety level, 9.5% of subjects scored at or above the computer anxious/tense level, and 4.8% of subjects scored at the very computer anxious level (see Table 38).

The decrease in the percentage of computer anxious subjects from the fall 1995 sample (23.8% versus 30.4%) is consistent with the increased percentage of computer owners in the spring 1996 sample (81.0% versus 68.5%). For the fall 1995 semester sample the mean pretest computer anxiety score for computer owners was 51.25 (SD = 14.15) and for non-computer-owners the score was 58.35 (SD = 16.24). Similarly, for the spring 1996 semester sample the mean pretest computer anxiety score for computer owners was 44.63 (SD = 14.65) and for non-computer-owners the score was 61.67 (SD = 15.56). These results provide evidence that computer owners are generally less computer anxious than individuals who do not own computers.

As expected, the percentage of subjects manifesting measurable levels of computer anxiety was lower at the posttest observation. Only 5.3% of the subjects scored at or above the mild computer anxiety level.

Treatments. Two semester-long computer literacy treatments were used for research question number 3: a cognitively-focused treatment ($\underline{N}$ = 29) and a humanistically-focused treatment ($\underline{N}$ = 28), with each treatment divided into two groups or sections (see Appendixes C, D, E, and F). Two instructors each taught a single group for each treatment in order to balance instructor effects between treatments. These treatments consisted of different versions of ECI 304, a required introductory computer literacy course in Old Dominion University's teacher education program. As such, both treatments were planned to provide similar computer knowledge, skills, and experiences, although not necessarily at the same levels of learning nor using the same methods of instruction. The two treatments were planned to differ along the following three dimensions:

1. The planned learning outcomes of the cognitively-focused treatment were exclusively from the cognitive domain (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and the planned learning outcomes of the humanistically-focused treatment were from both the cognitive and affective domains (Krathwohl, Bloom, & Masia, 1964).

2. The cognitively-focused treatment placed emphasis on presentation and application teaching methods and the humanistically-focused treatment placed emphasis on verbal interaction and application teaching methods.
3. The cognitively-focused treatment placed emphasis on teacher-initiated cognitive interactions and the humanistically-focused treatment placed emphasis on teacher-initiated affective interactions.

The expectation was that the more traditional cognitively-focused treatment, with its emphasis on computer knowledge, skills, and experiences, would reduce computer anxiety and increase computer confidence. Such changes would be consistent with previous research that provided evidence that such a treatment can be effective in these areas (Bandura, 1977, 1982; Koohang, 1986, 1989; Gardner, Discenza, & Dukes, 1993; Honeyman and White, 1987; Overbaugh, 1993; Rosen, Sears, & Weil, 1993; Savenye, Davidson, & Orr, 1992; Schunk, 1985, 1989; Torris, 1985).

Theoretical considerations suggested that a humanistically-focused treatment could be more efficacious in reducing computer anxiety and improving attitudes about computers because: (a) the emphasis in providing computer experience was on quality rather than quantity (Ertmer, Evenbeck, Cennamo, & Lehman, 1984); (b) opportunities were presented for attitudinal changes based on the inclusion of

learning outcomes from the affective domain that were meant to improve computer confidence, computer liking, and computer usefulness; (c) learning was provided in a context that provided acceptable means of voicing frustration and for obtaining encouraging feedback (Ertmer, Evenbeck, Cennamo, & Lehman, 1984); and (d) all three sources of computer anxiety (lack of operational experience, inadequate computer knowledge, and psychological makeup) were addressed (Howard, 1986).

Treatment fidelity. Two independent observers who observed 26.39% of all class meetings collected data (see Appendix I) that assisted the researcher in assessing treatment fidelity. Monthly examinations of interobserver agreement using the exact agreement method (Hittleman & Simon, 1992) provided evidence of the reliability of observer reports. With the exception of the first monthly examination that yielded a marginal interobserver agreement of 83.33%, the remaining successive monthly examinations of 95.83%, 100%, and 95.83% provided strong evidence of interobserver agreement.

An examination of study artifacts (i.e., treatment plans and syllabi, daily instructor journals that included lesson plans, and observer reports) provided evidence that both treatments were presented essentially as planned by both instructors.

The data provided by the independent observers yielded evidence that instructor journals provided an accurate description of actual class meetings. Furthermore, a comparison of instructor journals to treatment plans (see Appendixes C and D) and syllabi (see Appendixes E and F) provided evidence that the two treatments were conducted as planned. The student experiences in the cognitively-focused treatment supported planned learning outcomes that were exclusively from the cognitive domain and the student experiences in the humanistically-focused treatment supported planned learning outcomes that were from both the cognitive and affective domains.

Data from instructor journals, supported by observer reports, verified that the cognitively-focused treatment placed emphasis on presentation and application teaching methods by using these methods, on average, for 98% of the treatment. The humanistically-focused treatment placed emphasis on verbal interaction and application teaching methods by using these methods, on average, for 79% of the treatment. Only 2% of the of the cognitively-focused treatment consisted of the verbal interaction method while, on average, 14.5% of the humanistically-focused treatment consisted of this method. Intratreatment differences between instructors were negligible (see Table 41).

Data from observer reports showed that 93.5% of teacher-initiated interactions in the cognitively-focused treatment were cognitive interactions (e.g., how do you copy a file?) and 81.5% of teacher-initiated interactions in the humanistically-focused treatment were affective interactions (e.g., how important is this lesson to you?) for the observed class meetings. This data provided evidence that the cognitively-focused treatment placed emphasis on cognitive teacher-initiated interactions and the humanistically-focused treatment placed emphasis on affective teacher-initiated interactions as planned. Intratreatment differences between instructors were negligible (see Table 42).

Assumptions. Assumptions concerning extreme outliers and normality of the sampling distribution for computer usefulness were unsatisfactory because of four extremely low pretest outliers and three extremely low posttest outliers. The case with an extremely low pretest score of 27 ($z$ = -2.93) and extremely low posttest score of 29 ($z$ = -3.63) was deleted from further analysis because it was the only case with both pretest and posttest outliers. The extremely low scores of the remaining five cases were altered to bring them to within three box-lengths of the lower edge of the boxplot in accordance with the procedures recommended by Tabachnick and Fidell (1989). This action was accomplished by raising pretest scores from 26 (one case) and 29 (two cases) to 30,

and by increasing posttest scores from 30 (two cases) to 32. After the data were altered the assumptions concerning extreme outliers and normality of the sampling distribution for computer usefulness were tenable. Case deletion and data alteration did not bias the subsequent ANCOVA in favor of the humanistically-focused treatment because: (a) the deleted case with extremely low pretest and posttest outliers was from the cognitively-focused treatment, and (b) the two extremely low posttest outliers that were increased from 30 to 32 were from the cognitively-focused treatment.

Tests of the assumption of homogeneity of regression provided evidence that the assumption was tenable for computer anxiety, computer confidence, and computer liking because of the nonsignificant treatment and instructor interactions with each covariate. However, the assumption of homogeneity of regression was not tenable for computer usefulness because of the significant Treatment x Pretest Computer Usefulness interaction, $F(1, 50) = 4.11$, $p < .05$. This assumption is important because the ANCOVA model utilizes linear regression analysis that assumes a common slope for each cell in order to adjust the dependent variable by the covariate. Since the assumption of homogeneity of regression was not tenable, the ANCOVA model used for the computer usefulness analysis was fitted with separate slopes for each cell as recommended by Norusis (1994). The ANCOVA

model for computer anxiety, computer confidence, and computer liking were fitted with a common slope.

Homogeneity of variance was satisfied by Bartlett-Box $F$ tests for computer anxiety, $F(3, 4697) = .38$, computer confidence, $F(3, 4697) = 1.27$, computer liking, $F(3, 4697) = 1.40$, and computer usefulness, $F(3, 4475) = 1.99$, $ps > .05$. In each case the null hypothesis that all cell variances were equal was not rejected, thus satisfying the assumption.

Linearity between each dependent variable and its covariate was satisfied by visual inspection of bivariate scatterplots (see Figures 8, 9, 10, and 11). In each case the graph was mostly linear.

Based on the nature of the CAS and COMPAS scale development and data collection procedures there were no reasons to suspect that the assumption of reliability of any of the pretest covariates was violated. Additionally, since the covariates for this study were measured at the pretest observation prior to the treatments, there was no risk that adjustments for the covariates would remove variance due to the treatments.

Treatment effects. The subjects in the two treatment groups were compared on the following posttest scores: (a) computer anxiety, (b) computer confidence, (c) computer liking, and (d) computer usefulness (using altered data). Separate univariate ANCOVAs were conducted with the

appropriate pretest as the covariate in each analysis. The ANCOVA design was used to control statistically any initial dependent variable differences in the subjects which might have been present and which might confound posttest differences between the two groups. Additionally, use of covariate data within the analysis provided for a more powerful statistical analysis than use of the posttest data alone.

Based on the significant regression effect for computer anxiety, $F(1\ 52) = 46.05$ (see Table 45), computer confidence, $F(1, 52) = 41.46$ (see Table 46), computer liking, $F(1, 52) = 55.73$ (see Table 47), and computer usefulness, $F(1, 51) = 18.41$ (see Table 48), $ps < .001$, the null hypothesis that the slope of the regression line was 0 was rejected for each analysis. This means that for each ANCOVA, the covariate resulted in an adjustment to the dependent variable.

Only one of the four ANCOVAs produced a significant treatment effect. The humanistically-focused treatment was more effective than the cognitively-focused treatment in improving attitudes about the usefulness of computers, $F(1, 51) = 7.09$, $p < .01$ (see Table 48). Additionally, paired $t$ tests showed that the humanistically-focused treatment resulted in a significant increase in computer usefulness, $t(27) = 3.30$, $p < .01$, while the cognitively-focused

treatment resulted in no significant change in computer usefulness, $t(28) = 1.00$ (see Table 43).

Since Glass and Hopkins (1996) maintain that the credibility of ANCOVA findings is reduced when the amount of extrapolation is large, an examination of the adjusted and unadjusted posttest computer usefulness means was made. This examination showed that the amount of extrapolation was small (see Table 49).

Since the observed computer usefulness data were altered to remove extreme outliers, computer usefulness analyses were also conducted using the unaltered data, notwithstanding violations of assumptions, in order to detect possible evidence of bias as the result of altering data and deleting a case. The ANCOVA and paired $t$ tests produced consistent findings regardless of the computer usefulness data used.

The effectiveness of the humanistically-focused treatment in increasing the attitude of computer usefulness was anticipated because: (a) the humanistically-focused treatment included two planned learning outcomes related to computer usefulness whereas the cognitively-focused treatment had none, and (b) the humanistically-focused treatment provided the opportunity for more verbal interaction.

The two learning outcomes related to computer usefulness used in the humanistically-focused treatment were: (a) the student will summarize the impact of computer technology on

education and describe the major reasons for using technology in the classroom, and (b) the student will believe that positive outcomes can result from use of computer technology in the classroom. Student experiences that supported these learning outcomes are described in Appendix D. However, one cannot be completely assured that the significant computer usefulness effect resulted exclusively from student experiences related to the two planned computer usefulness learning outcomes. The humanistically-focused treatment also differed from the cognitively-focused treatment on methods of instruction (see Table 41) and types of teacher-initiated student interactions (see Table 42). These treatment differences may have worked alone or in some combination to produce the significant increase in computer usefulness. For example, the increased opportunity in the humanistically-focused treatment for voicing uncertainty and frustration and for obtaining positive and encouraging feedback may have contributed to a heightened awareness of the usefulness of computers in education.

Not expected was the finding that the two treatments were not significantly different from each other in changing computer anxiety, $F(1, 52) = 2.38$, $MSE = 50.40$ (see Table 45). However, paired $t$ tests showed that both treatments resulted in significant reductions in computer anxiety ($t(28) = 3.20$, $p < .01$ for the cognitively-focused course and $t(27)$

= 4.44, p < .001 for the humanistically-focused course) (see Table 43). Both treatments were planned to provide computer knowledge and experience, and as such treat Howard's (1986) computer knowledge and computer experience sources of computer anxiety. Prior research provided substantial evidence that such treatments can reduce computer anxiety (Honeyman and White, 1987; Overbaugh, 1993; Rosen, Sears, & Weil, 1993; Savenye, Davidson, & Orr, 1992; Torris, 1985). However, the humanistically-focused treatment was also planned to include affective domain learning outcomes to improve attitudes about computers. Thus the humanistically-focused treatment addressed all three of Howard's (1986) sources of computer anxiety while the cognitively-focused treatment addressed only two sources. The absence of a significant computer anxiety effect between the two treatments suggests that lack of operational experience and inadequate knowledge about computers are easier sources of computer anxiety to treat than the psychological makeup source.

Also not expected was the finding that the two treatments were not significantly different from each other in changing computer confidence, $F(1, 52) = 1.19$, MSE = 8.74 (see Table 46). Past research provided evidence that treatments, such as the ones used in this study, which include computer experience (Koohang, 1986, 1989; Gardner,

Discenza, & Dukes, 1993) and anxiety reduction and performance accomplishments (Bandura, 1977, 1982; Schunk, 1985, 1989) can improve computer confidence. As expected, both treatments resulted in significant increases in computer confidence ($t(28) = 4.03$, $p < .001$ for the cognitively-focused course, and $t(27) = 3.27$, $p < .01$ for the humanistically-focused course) (see Table 43). However, it was expected that the humanistically-focused course would be more efficacious because of its emphasis on attitude improvement.

Neither treatment was superior in changing computer liking, $F(1, 52) = .50$, $MSE = 13.09$ (see Table 47), and paired t tests showed that neither treatment was able to significantly change computer liking ($t(28) = .59$ for the cognitively-focused course and $t(27) = 2.04$ for the humanistically-focused course) (see Table 43). This finding suggests that computer liking is a difficult attitude to change during a 13 week computer literacy course or, more fundamentally, the treatments used in this study were not properly structured to change the attitude of computer liking.

The ultimate test of the superiority of any treatment over all others rests in its relative ability to reduce computer avoidance in teachers so as to help achieve the potential benefits of computer technology for education.

While both treatments were able to reduce computer anxiety and increase computer confidence, the humanistically-focused treatment may be the superior treatment in reducing computer avoidance given its ability to also increase the attitude of computer usefulness. However, additional research is required before any conclusions can be drawn.

Instructor and Treatment x Instructor interaction effects. As expected, the instructor main effects were nonsignificant for computer anxiety, $F(1, 52) = 2.62$, $MSE = 50.40$ (see Table 45), computer confidence, $F(1, 52) = 1.02$, $MSE = 8.74$ (see Table 46), computer liking, $F(1, 52) = .10$, $MSE = 13.09$ (see Table 47), and computer usefulness, $F(1, 51) = .02$, $MSE = 2.50$ (see Table 48), indicating that both instructors were essentially equivalent on their abilities to reduce computer anxiety and improve computer attitudes. Similarly, the Treatment x Course Instructor interactions were nonsignificant for computer anxiety, $F(1, 52) = .33$, $MSE = 50.40$ (see Table 45), computer confidence, $F(1, 52) = .21$, $MSE = 8.74$ (see Table 46), computer liking, $F(1, 52) = .13$, $MSE = 13.09$ (see Table 47), and computer usefulness, $F(1, 51) = 1.67$, $MSE = 2.50$ (see Table 48), indicating that both instructors achieved similar results in reducing computer anxiety and improving computer attitudes in the cognitively-focused treatment and in the humanistically-focused treatment.

The absence of significance in both effects provided evidence that researcher effects were not a serious threat to the validity of this study because instructor number 2 was the researcher. If the instructor main effect was significant in favor of instructor number 2, one could argue that the instructional techniques were complex and could only be implemented effectively by someone with the researcher's special knowledge and dedication. If the Course Instructor x Treatment interaction was significant in favor of instructor number 2 for the humanistically-focused treatment, one could argue that the researcher exerted undue influence on the subjects in the humanistically-focused treatment to perform better on outcome variables than the subjects in the cognitively-focused treatment.

A MANOVA using Pillai's criterion showed that the combined evaluations of student responses to seven questions on the course evaluation questionnaire (see Appendix K) were significantly affected by group instructor, $F(7, 49) = 4.93$, $p < .001$, but not by treatment type, $F(7, 49) = 1.35$. This means that, on the average, students evaluated the treatments taught by instructor number 1 higher than the treatments taught by instructor number 2 (see Table 50), while no significant differences were found on how subjects evaluated the two different treatments regardless of instructor. Despite these differences in course evaluations, both

instructors were effective in reducing computer experience and improving attitudes about computers.

Issues. In contrast to true experimental designs, the quasi-experimental design used in this study is subject to difficulties in interpretation. Although ANCOVA was used to statistically equate groups on the pretest measurement of the applicable dependent variable, one cannot be assured that bias was not present from a confounding variable that was overlooked. In other words, one cannot conclude that the groups were equal in the sense of randomization.

## Implications of the Findings

The results of this study have implications for both educational practice and current theory. Five implications are described below.

### Main Implication

Computer anxiety appears to affect many teacher education students and, when it exists, is treatable. Colleges of education should note that a properly structured introductory computer literacy course can reduce computer anxiety and improve the attitudes of computer confidence and computer usefulness in teacher education students. These benefits can continue to accrue beyond course termination in the form of increased computer use, further reductions in computer anxiety, and the improvement of confidence in using computers. These results suggest that a computer literacy

course for teacher education students should be a mandatory course taken early in the preservice program in order to provide ample time for students to internalize and make use of the full range of immediate and delayed benefits.

Second Implication

The content of a computer literacy course can vary significantly and remain effective in reducing computer anxiety and increasing computer confidence in teacher education students. However, evidence from this study suggests that for the attitude of computer usefulness to improve significantly, a specific educational goal supported by appropriate learning outcomes and/or methods of instruction must be part of the treatment.

Third Implication

The effectiveness of a computer literacy course in reducing computer anxiety appears to vary significantly according to the instructor conducting the treatment in ways that are not yet understood. Other, more subtle variables are at play. For an introductory computer literacy course to achieve its potential of reducing computer anxiety and increasing attitudes about computers, colleges of education should carefully select instructors for computer literacy courses and confirm their abilities to promote computer anxiety reduction and positive attitudes about computers.

Fourth Implication

Study findings suggest three refinements to Howard's (1986) theory of computer anxiety.

First, the effectiveness of a computer literacy course in reducing computer anxiety appears to be sensitive to how the treatment is interpreted by the students. Howard makes no mention of this condition. A positive interpretation can result in a significant reduction in computer anxiety. A less positive or negative interpretation can result in no significant decrease in computer anxiety. However, the important factors that explain how a student interprets the course are not yet identified, although this study provides some evidence that the course instructor plays an important role.

Second, computer confidence is the most significant component of an individual's psychological makeup examined by this study that is related computer anxiety. Howard does not identify the significant role of computer confidence in explaining computer anxiety. Study findings show that it has a strong negative correlation ($r < -.70$) with computer anxiety. Furthermore, multiple regression analysis that was conducted to explain and predict computer anxiety at the end of a computer literacy course showed that computer confidence, $\beta = -.62$, was the strongest predictor of posttest

computer anxiety when considered with trait anxiety, $\beta = .26$, and computer knowledge, $\beta = -.22$.

Third, this study provides evidence that computer confidence can be readily treated by a computer literacy course, in contrast to Howard's view that attitudes, which are related to an individual's psychological makeup, are very difficult to change.

Fifth Implication

Teacher education counselors and advisors may find it useful to view computer confidence, computer knowledge, and trait anxiety as reliable predictors of posttest computer anxiety. Teacher education students who are resistant to reduction of computer anxiety may require psychological counseling (Rosen, Sears, & Weil, 1993) and/or additional computer instruction (Howard, 1986; Rosen & Maguire, 1990).

## Recommendations for Further Research

There is potential for numerous related studies that replicate and extend this study within the urban education framework. Three directions for further research are described below.

Direction Number 1

Can the results of this study be replicated and extended? For example, can similar results be obtained using different samples and different settings? What are the effects of a humanistically-focused treatment in reducing

computer anxiety and improving attitudes about computers over time? What were the important elements of the humanistically-focused treatment that resulted in the significant increase in the attitude of computer usefulness? What are the effects of a computer literacy course on computer anxiety and attitudes about computers based on behavioral and physiological indicators (e.g., respiration rate, heart rate, blood pressure, and galvanic skin response)?

Replication will help confirm or disconfirm the validity of the new evidence presented in this study. Extension will check the validity of research findings across different populations and check trends over time.

Direction Number 2

What are the important differences between teachers who are able to significantly reduce computer anxiety and improve attitudes about computers in their students and teachers who are less successful in this regard? What teaching methods are important in this regard?

This study provided evidence that treatment efficacy varies according to the instructor conducting the treatment in ways that are not understood, despite similar treatments and subjects and identical textbooks and venues. An understanding of the factors that make an instructor effective in reducing computer anxiety and improving computer attitudes can assist colleges of education in selecting and

training teachers to conduct computer literacy courses and can be incorporated into methods courses that include use of computer-based technologies.

Direction Number 3

What is the best type of treatment for dealing with computer anxious individuals who are resistant to reductions in computer anxiety?

At the end of the computer literacy treatments used in this study 14.0% of fall 1995 semester and 5.3% of spring 1996 semester subjects still manifested computer anxiety at or above the mild anxiety level. These results provide evidence some individuals are resistant to computer anxiety reduction. Either psychologically-based treatments, such as the one used by Rosen, Sears, and Weil (1993), or treatments that provides computer experience and knowledge can be effective in reducing computer anxiety. However, research is needed to determine how to reduce computer anxiety in individuals resistant to reduction of computer anxiety. If the major source of computer anxiety in such individuals is their psychological makeup, a psychologically-based treatment may be more efficacious for these individuals.

Direction Number 4

What are the relationships between computer avoidance in public school teachers and computer anxiety, computer confidence, computer liking, and computer usefulness? Are

there other, more important variables that can explain computer avoidance in teachers? How does a preservice computer literacy course, such as the ones used in this study, influence classroom computer use by subjects when they become teachers? Is a humanistically-focused treatment more effective than a cognitively-focused treatment in this regard?

The ultimate benefit of educating teacher education students about technology and making them comfortable using computers is that they will use this technology when they become classroom teachers. Future research should examine the relationships between computer anxiety and attitudes about computers and the use of computers in the classroom by teachers.

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# APPENDIX A

## SUBJECT ORIENTATION

(Introduction of researcher.)

My research study examines attitudes and feelings about computers.

A major purpose of this research is to determine the most effective approach for teaching an introductory educational computer course.

The study does not involve evaluating instructors.

Subjects for this study are ECI 304 students who volunteer to participate.

Prior computer knowledge and experience are not prerequisites for participating in this study.

A high volunteer rate is required, otherwise the results of the study may not be valid. This is because volunteers are likely to be a biased sample of the target population since volunteers have been found in many studies to differ from nonvolunteers. For example, according to Borg and Gall (1989) volunteers tend to: (a) be better educated, (b) have higher social-class status, (c) be more intelligent, (d) be higher in need of social approval, and (e) be more sociable.

Your participation in this study provides you the opportunity to become involved in academic change. The higher the volunteer rate, the greater the applicability of study results to all ECI 304 students. A high volunteer rate will

help maintain the validity of study results and result in a more persuasive study that may result in change.

Volunteers will be given time during class to complete all questionnaires, except for fall semester ECI 304 students when they complete the final three questionnaires in March 1996. To reimburse these volunteers for their out-of-class effort, each volunteer who completes and returns the final three questionnaires will receive a $5.00 check by return mail.

The mean time to complete five questionnaires in one sitting, which volunteers will be asked to do today, is approximately 20 minutes. Remaining testing sessions will be significantly shorter.

Questions?

(Pass out Subject Consent Forms.)

This form is an adaptation of the standard ODU Subject Consent Form that covers all forms of research, from physically and emotionally stressful research such as electric shock and sensory deprivation, to relatively benign survey research such as this. It has been approved by the university.

(Read the Subject Consent Form.) (Students follow along and enter their name on the first page.)

Questions?

Volunteers are to sign and date Subject Consent Forms.

It will be very helpful if those who do not volunteer describe their reasons for not volunteering on the last page of the Subject Consent Form.

Nonvolunteers will be given an in-class assignment by your instructor.

Witnesses are to sign and date Subject Consent Forms.

(Collect Subject Consent Forms.)

(Pass out the appropriate questionnaires.)

Volunteers are to complete all questionnaires.

Nonvolunteers are asked to complete the Start-of-Study Questionnaire anonymously.

Respond to questions independently; don't go back to review earlier responses.

Once you start, go from questionnaire to questionnaire. Do not pause between questionnaires.

There are no correct or wrong answers.

Answer every question. In some instances you may discover that you believe there is more than one correct answer for you. In such cases, be sure to select the one response you more strongly believe to be the case as far as you're concerned. In other instances, you may not like any of the responses. In these cases, select the response that bothers you the least.

Enter the start and finish times for <u>each</u> questionnaire in the spaces provided. (For the pilot study only.)

Raise your hand if you need help completing the questionnaires.

When you finish all questionnaires give them to me and take a break.

Information concerning local addresses and phone numbers are required only from volunteers enrolled in ECI 304 during the fall semester. This information will only be used to mail the final questionnaires to volunteers in March 1996 and to phone subjects if necessary.

Are there any final questions?

(Instructor gives assignment for nonvolunteers.)

Start.

# Appendix B

## SUBJECT CONSENT FORM

Computer Attitudes of Teacher Education Students

Investigator

Fred Rovai, Department of Educational Curriculum and Instruction, Darden College of Education, Old Dominion University.

Description

Several studies have been conducted examining the computer attitudes and feelings of teacher education students and the effects of various courses on these attitudes and feelings. The purpose of this investigation is to evaluate the effects of ECI 304 on these attitudes and feelings and to determine the most effective approach for teaching this course.

I, ________________________, have agreed to participate as a subject in this study. I understand that I will be participating in a study involving the following requirements:

1. For participants in the pilot study (summer semester 1995): (a) completion of consent form, (b) completion of six questionnaires at the start of ECI 304, and (c) completion of six questionnaires at the end of ECI 304.

2. For participants in the main study who are enrolled in ECI 304 during the fall semester: (a) completion of consent form,

(b) completion of five questionnaires at the beginning of the semester; (c) completion of two questionnaires at the end of the semester, and (d) completion of three questionnaires in March 1996.

3. For participants in the main study who are enrolled in ECI 304 during the spring semester: (a) completion of consent form, (b) completion of five questionnaires at the beginning of the semester and (c) completion of three questionnaires at the end of the semester.

Exclusionary Criteria

I understand that to participate in this study I must: (a) be enrolled in ECI 304 and intend to remain at the university through the spring 1996 semester, (b) be at least 18 years of age, (c) freely volunteer to participate in this study, (d) not be concurrently enrolled in another computer literacy course, (e) be enrolled in a teacher education program, and (f) not be repeating ECI 304. To the best of my knowledge I am not aware of any conditions that would prohibit my participation in this study.

Risks and Benefits

The questionnaires that I will complete during this study will result in my divulging general demographic information about myself (e.g., academic major), data concerning my prior computer knowledge and experience, my present intent to use computers in the classroom, and my

personal attitudes and feelings. Personal risks arising out of participation in this study is estimated to be minimal. However, I understand that all precautions will be taken to ensure my safety. There also exists the possibility that I may be subject to risks that have not yet been defined.

I understand that the main benefits to accrue from this study are the attainment of information relative to the effects of ECI 304 on computer attitudes and improvement of ECI 304. I also understand that pertinent information relative to my responses to questionnaires will be discussed with me by Fred Rovai at the conclusion of my participation in this study if I desire.

Costs and Payments

I understand that my efforts in this study are voluntary and I will not receive remuneration to help defray incidental expenses associated with my participation, except as follows. If enrolled in ECI 304 during the fall 1995 semester, I will receive a $5.00 check by return mail after I complete and return the final three questionnaires in March 1996.

New Information

Any new information obtained during the course of this research that may be relative to my willingness to continue to participate in this study will be provided to me.

Confidentiality

I understand that any information obtained about me from this research will be kept strictly confidential. No information about me, other than what I provide in response to questionnaires, will be obtained and used in this study.

I also understand that the data derived from this study could be used in reports, presentations, and publications, but that I will not be individually identified. My name will not appear in any study report. I do understand, however, that my records may be subpoenaed by court order or may be inspected by Federal regulatory authorities.

Withdrawal Privilege

I understand that I am free to refuse to participate in this study or to withdraw at any time and that my decision to withdraw will not adversely affect my status at this institution or cause a loss of benefits to which I might otherwise be entitled. Participation or nonparticipation in this study will not affect my course grade. I also realize that the investigator may withdraw my participation at any time throughout this study if he observes any contraindication for study continuance.

Compensation for Illness or Injury

I understand that in the unlikely event of injury or illness resulting from the research protocol, no monetary compensation will be made, but any immediate emergency medical treatment which may be necessary will be available to

me without charge by the investigator. I am advised that if any injury should result from my participation in this research project, Old Dominion University does not provide any insurance coverage, compensation plan, or free medical care planned to compensate me for such injuries. In the event that I have suffered injury as a result of my participation in this study I may contact Fred Rovai at 804-479-0523, who will be glad to review the matter with me.

Voluntary Consent

I certify that the preceding has been read to me and that I understand the contents and that any questions I have pertaining to the research have been, or will be answered by Fred Rovai. If you have any concerns you would like to express to the Old Dominion University Protection of Human Subjects Committee, please feel free to contact them. The Chair of the Darden College of Education Research and Scholarship Committee is Dr. Steven Purcell, phone 804-683-5684. A copy of this consent form will be given to me. My signature below means that I am at least 18 years old and freely agree to participate in this study.

____________________________________ ____________

Subject's signature Date

____________________________________ ____________

Witness's signature Date

I certify that I have explained to the above individual the nature and purpose of the potential benefits, and possible risks associated with participation in this study. I have answered any questions that have been raised and have witnessed the above signature. I have explained the above to the volunteer on the date stated on this consent form.

Investigator's signature Date

# APPENDIX C

## COGNITIVELY-FOCUSED TREATMENT PLAN

### Policies

Learning outcomes: Instructors will state learning outcomes at the beginning of each class meeting.

Instructor journal: Instructors will maintain a daily journal using a computer word processor. Copies of the journal computer file will be transmitted to the researcher via the Internet each week. Instructors will use the journal to record the following information for each lesson: (a) lesson date and time; (b) affective domain learning outcomes (if any); (c) approximate time devoted to affective domain learning outcomes; (d) cognitive domain learning outcomes (if any); (e) approximate time devoted to cognitive domain learning outcomes; (f) teaching methods used (presentation method, verbal interaction method, and/or application method); (g) approximate time devoted to each teaching method; (h) experiences provided students; (i) computer software and hardware used; (j) list of materials used (e.g., transparencies, videotape, chalkboard, etc.); and (k) any additional remarks that the instructor considers useful for documenting the treatment.

## Text and Materials

Textbook: Presley, B., Brown, B. (1995). An introduction to computing using Microsoft Works version 3 for Windows. Pennington, NJ: Lawrenceville Press.

Computers and appropriate software will be available for each student.

## Teaching Methods

Instructors will use the following teaching methods, as appropriate:

1. Presentation method: includes lecture (formal or informal presentation of information, concepts, or principles by a single individual, with or without questioning), panel discussion, demonstration-performance (presentation or portrayal of a sequence of events to show a procedure), reading (books, periodicals, handouts, etc.), and self-paced (programmed instruction).
2. Verbal interaction method: questioning and discussion, including guided discussion (teacher-facilitated interactive process of sharing information, experiences, and feelings) and nondirected discussion (such as peer-controlled group discussion).
3. Application method: provides learners with opportunities to apply learned material, e.g., using a computer. Includes individual and group projects, case studies (including discussion), and simulations (e.g., role-playing and games).

This cognitive treatment places emphasis on presentation and application teaching methods to achieve learning outcomes.

## Goals, Learning Outcomes, and Experiences

### Goal: Learning about Computer Technology (Cognitive Domain)

Learning outcome number 1. The student will outline the history of computers (knowledge level). Student experience: listen to a lecture on the history of computers.

Learning outcome number 2. The student will explain important terms used in computer technology (comprehension level). Student experience: listen to a lecture on computer terminology.

Learning outcome number 3. The student will summarize the function and operation of major components of computer hardware (i.e., memory (RAM/ROM), Central Processing Unit, input devices, storage devices, and output devices) (comprehension level). Student experience: listen to a lecture and observe a demonstration of the operation of major components of computer hardware.

### Goal: Learning about Educational Applications of Computer Technology (Cognitive Domain)

Learning outcome number 4. The student will explain the potential range of software (comprehension level). Student experience: listen to a lecture on the major types and educational uses of software (i.e., tutor, tool, and tutee).

Learning outcome number 5. The student will summarize the concept of the integration of computers into teaching and learning (comprehension level). Student experiences:

1. Listen to a lecture on computer assisted instruction, computer managed instruction (productivity tools), and curriculum integration (moving beyond computer literacy).
2. Discuss the distinction between computer infusion (placing computers in schools in order to develop computer literacy) and computer integration (totally integrating the use of computers into the curriculum through learning activities that address subject-area learning outcomes), setting forth the characteristics and advantages of each.

Learning outcome number 6. The student will evaluate educational software (application level). Student experiences:

1. Listen to a lecture on the evaluation of software for educational purposes and on the identification of outstanding software.
2. Evaluate an educational software package.

Learning outcome number 7. The student will explain the ethical issues of computer usage (comprehension level). Student experience: listen to a lecture on software piracy, hackers, viruses, and computer crime.

Learning outcome number 8. The student will explain and give examples of: (a) desktop publishing, (b)

multimedia/hypermedia, and (c) networking and telecommunications (comprehension level). Student experiences:

1. Listen to a lecture on desktop publishing software.
2. Listen to a lecture and observe a demonstration of multimedia software (including interactive multimedia environments, hypermedia, and supporting technologies).
3. Listen to a lecture on computer networking (i.e., workgroups; local area networks; wide area networks; information services such as CompuServe, Prodigy, America On-Line, Dow Jones News/Retrieval, and Accu-Weather; and research networks).
4. Listen to a lecture on cross-platform compatibility issues (e.g., reading PC files using a Macintosh computer, running PC software on a Macintosh, and mixed PC and Macintosh networks).
5. Listen to a lecture on telecommunications (i.e., the nature of telecommunications, hardware and software, and common telecommunications applications including practical classroom applications).
6. Listen to a lecture on the Internet and observe a demonstration of Internet access (including use of electronic mail, newsgroups, File Transfer Protocol, Gopher, and World Wide Web services).

Goal: Acquiring Skills with the Microcomputer (Cognitive Domain)

Learning outcome number 9. The student will demonstrate skill in using word processing software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of word processing software (including basic concepts, word processor functions, writing aids, the process approach to writing, and editing/revision).
2. Perform guided and individual practice using word processing software.

Learning outcome number 10. The student will demonstrate skill in using database management software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of database management software (including basic concepts, database functions, data management in education, and database resources such as the Educational Resources Information Center (ERIC)).
2. Perform guided and individual practice using database management software.
3. Listen to a lecture on the steps in planning and conducting an ERIC database search (select descriptors, conduct the search, and review the printout) and plan and conduct an ERIC database search.

Learning outcome number 11. The student will demonstrate skill in using spreadsheet software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of spreadsheet software (including basic concepts, spreadsheet functions, categories of spreadsheet applications, and classroom applications).
2. Perform guided and individual practice using spreadsheet software.

Learning outcome number 12. The student will demonstrate skill in using desktop presentation software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of desktop presentation software (including the preparation of overhead transparencies, lecture outlines, prepared discussion questions, and graphics to stimulate thinking).
2. Perform guided and individual practice using desktop presentation software.
3. Design and layout overhead transparencies using desktop presentation software.

General Activities

Students will also experience the following general activities: (a) homework assignments (including reading pertinent portions of the textbook, preparing word processing documents, and preparing paper output of overhead

transparencies); (b) periodic tests (2-4 topic tests, primarily computer-based); and (c) a final comprehensive examination.

# APPENDIX D

## HUMANISTICALLY-FOCUSED TREATMENT PLAN

### Policies

Learning outcomes: Instructors will state learning outcomes at the beginning of each class meeting.

Instructor journal: Instructors will maintain a daily journal using a computer word processor. Copies of the journal computer file will be transmitted to the researcher via the Internet each week. Instructors will use the journal to record the following information for each lesson: (a) lesson date and time; (b) affective domain learning outcomes (if any); (c) approximate time devoted to affective domain learning outcomes; (d) cognitive domain learning outcomes (if any); (e) approximate time devoted to cognitive domain learning outcomes; (f) teaching methods used (presentation method, verbal interaction method, and/or application method); (g) approximate time devoted to each teaching method; (h) experiences provided students; (i) computer software and hardware used; (j) list of materials used (e.g., transparencies, videotape, chalkboard, etc.); and (k) any additional remarks that the instructor considers useful for documenting the treatment.

Promoting positive attitudes: instructors will promote positive attitudes by providing early, successful experiences followed by positive attributional feedback. Additionally,

instructors should place emphasis on manifesting the following humanistic characteristics as identified by Richardson and Morgan (1990): (a) accept students as they are; (b) assume students want to learn; (c) expect considerable achievement; (d) praise whenever appropriate; (e) be critical in a constructive manner; (f) be honest with students; (g) accentuate the positive, i.e., build on strengths; (h) talk with students, not at students; (i) have a sense of humor; (j) trust students and exude warmth; and (k) be enthusiastic. Additionally, instructors will place emphasis on asking affective (versus cognitive) questions throughout the course. (How did that make you feel (after a session on the computer)? Why is this lesson important to you? Why did you like what you just did on the computer?)

## Text and Materials

Textbook: Presley, B., Brown, B. (1995). An introduction to computing using Microsoft Works version 3 for Windows. Pennington, NJ: Lawrenceville Press.

Videotape: The course will include a 30-minute videotape, Teaching and Learning with Technology (Asen, 1994). This videotape highlights three different school settings. Each segment represents a different example of the use of technology as a learning and teaching tool.

Computers and appropriate software will be available for each student.

## Teaching Methods

Instructors will use the following teaching methods, as appropriate:

1. Presentation method: includes lecture (formal or informal presentation of information, concepts, or principles by a single individual, with or without questioning), panel discussion, demonstration-performance (presentation or portrayal of a sequence of events to show a procedure), reading (books, periodicals, handouts, etc.), and self-paced (programmed instruction).
2. Verbal interaction method: questioning and discussion, including guided discussion (teacher-facilitated interactive process of sharing information, experiences, and feelings) and nondirected discussion (such as peer-controlled group discussion).
3. Application method: provides learners with opportunities to apply learned material, e.g., using a computer. Includes individual and group projects, case studies (including discussion), and simulations (e.g., role-playing and games).

This humanistic treatment places emphasis on verbal interaction and application teaching methods to achieve learning outcomes.

Goals, Learning Outcomes, and Experiences

Goal: Learning about Computer Technology (Cognitive Domain)

Learning outcome number 1. The student will explain important terms used in computer technology (comprehension level). Student experience: listen to a lecture on computer terminology.

Learning outcome number 2. The student will summarize the function and operation of major components of computer hardware (i.e., memory (RAM/ROM), Central Processing Unit, input devices, storage devices, and output devices) (comprehension level). Student experience: listen to a lecture and observe a demonstration of the operation of major components of computer hardware.

Goal: Learning about Educational Applications of Computer Technology (Cognitive Domain)

Learning outcome number 3. The student will explain the potential range of software (comprehension level). Student experience: listen to a lecture on the major types and educational uses of software (i.e., tutor, tool, and tutee).

Learning outcome number 4. The student will summarize the concept of the integration of computers into teaching and learning (comprehension level). Student experiences:

1. Listen to a lecture on computer assisted instruction, computer managed instruction (productivity tools), and curriculum integration (moving beyond computer literacy).

2. Discuss the distinction between computer infusion (placing computers in schools in order to develop computer literacy) and computer integration (totally integrating the use of computers into the curriculum through learning activities that address subject-area learning outcomes), setting forth the characteristics and advantages of each.

Learning outcome number 5. The student will evaluate educational software (application level). Student experiences:

1. Listen to a lecture and discuss the evaluation of software for educational purposes and the identification of outstanding software.

2. Evaluate an educational software package.

Learning outcome number 6. The student will explain the ethical issues of computer usage (comprehension level). Student experience: listen to a lecture on software piracy, hackers, viruses, and computer crime.

Learning outcome number 7. The student will explain and give examples of: (a) desktop publishing, (b) multimedia/hypermedia, (c) database management, (d) spreadsheets, and (e) networking and telecommunications (comprehension level). Student experiences:

1. Listen to a lecture and observe a demonstration of desktop publishing software.

2. Listen to a lecture and observe a demonstration of multimedia software (including interactive multimedia environments, hypermedia, and supporting technologies).

3. Listen to a lecture and observe a demonstration of database management software (including basic concepts, database functions, data management in education, and database resources such as the Educational Resources Information Center (ERIC)).

4. Listen to a lecture on the steps in planning and conducting an ERIC database search (select descriptors, conduct the search, and review the printout) and plan and conduct an ERIC database search (this experience supports learning outcome number 8, experience number 2).

5. Listen to a lecture and observe a demonstration of spreadsheet software (including basic concepts, spreadsheet functions, and categories of spreadsheet applications).

6. Listen to a lecture on computer networking (i.e., workgroups; local area networks; wide area networks; information services such as CompuServe, Prodigy, America On-Line, Dow Jones News/Retrieval, and Accu-Weather; and research networks).

7. Listen to a lecture on cross-platform compatibility issues (e.g., reading PC files using a Macintosh computer, running PC software on a Macintosh, and mixed PC and Macintosh networks).

8. Listen to a lecture on telecommunications (i.e., the nature of telecommunications, hardware and software, and common telecommunications applications).

9. Listen to a lecture on the Internet and observe a demonstration of Internet access (including use of electronic mail, newsgroups, File Transfer Protocol, Gopher, and World Wide Web services).

10. Identify and discuss potential classroom applications of desktop publishing (e.g., creative expression, production of flyers, announcements, brochures, newsletters, and newspapers), multimedia/hypermedia (e.g., research, individual instruction, interactive learning, mixing different learning modalities, and enrichment), database management (e.g., information management, use of commercial database resources, research, recording surveys, organize writing, relationships, and analysis of information), and spreadsheet (e.g., planning, math, budgets, sports statistics, tracking weather, comparisons, energy use, business, marketing, relationships, simulations, and analysis of information) software and networking (e.g., workgroups and printer sharing) and telecommunications (e.g., research, information access, electronic mail, distance learning, mentoring, and guest experts).

Learning outcome number 8. The student will summarize the impact of computer technology on education and describe

the major reasons for using technology in the classroom (comprehension level). Student experiences:

1. Listen to a lecture on the impact of computer technology on teaching and learning.
2. Prepare a short paper (i.e., 1 - 2 pages) based on a selected research journal article that describes a specific instance of the positive impact of computer technology on learning or teaching (students will use the ERIC database to identify appropriate articles).
3. Prepare and deliver a five minute presentation that summarizes a documented instance of the positive impact of computer technology on learning or teaching.
4. Listen to and discuss student presentations that summarize a documented instance of the positive impact of computer technology on learning or teaching.
5. Discuss and critique the major reasons identified by Peck and Dorricott (1994) for using computer technology in the classroom (i.e., students learn and develop at different rates; graduates must be proficient at accessing, evaluating, and communicating information; technology can foster an increase in the quantity and quality of students' thinking and writing; graduates must solve complex problems; technology can nurture artistic expression; graduates must be globally aware and able to use resources that exist outside the school; technology creates opportunities for students to

do meaningful work; all students need access to high-level and high-interest courses; students must feel comfortable with the tools of the Information Age; and schools must increase their productivity and efficiency.)

Goal: Acquiring Skills with the Microcomputer (Cognitive Domain)

Learning outcome number 9. The student will demonstrate skill in using word processing software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of word processing software (including basic concepts, word processor functions, writing aids, the process approach to writing, and editing/revision).
2. Perform guided and individual practice using word processing software.
3. Identify and discuss potential classroom applications of word processing software (e.g., writing, creative expression, and communication).

Learning outcome number 10. The student will demonstrate skill in using desktop presentation software (application level). Student experiences:

1. Listen to a lecture and observe a demonstration of desktop presentation software (including the preparation of overhead transparencies, lecture outlines, prepared discussion questions, and graphics to stimulate thinking).

2. Perform guided and individual practice using desktop presentation software.

3. Identify and discuss potential classroom applications of desktop presentation software (e.g., creative expression, overhead transparencies, and multimedia presentations).

Goal: Forming Attitudes about Computers (Affective Domain)

Learning outcome number 11. The student will like to use microcomputers (valuing level). (Learning outcome number 13 supports this outcome.) Student experiences:

1. Students will: (a) participate in biweekly likes and dislikes activities (early in the course students individually start a "Computer Likes & Dislikes Journal" in their notebooks (i.e., what I like about computers, what I dislike about computers, and why); (b) maintain their journals noting their feelings and thoughts about computers and any attitude changes; (c) engage in periodic guided group discussions that explore their likes and dislikes (Has anyone clarified or changed their computer likes or dislikes since our last discussion? Why or why not? Is it important for you to eliminate your computer dislikes? Why or why not? How can I help? What is the impact of your computer likes and dislikes?); and (d) be provided feelings of universality if they are uncomfortable about using computers by the demonstration that they are not alone in their discomfort.

2. Observe demonstrations of various entertainment/educational software packages that have potential use in the classroom.

Learning outcome number 12. The student will believe that positive outcomes can result from use of computer technology in the classroom (valuing level). (Learning outcome number 8 supports this outcome.) Student experiences:

1. Participate in a warm-up activity by: (a) determining and recording on a worksheet the characteristics, skills, and attitudes of a good learner; (b) sharing ideas during class discussion while the instructor records key phrases for everyone to see; and (c) listening to the instructor summarize student responses.

2. Identify and discuss the possible roles of computer technology in today's classroom in order to build student background prior to viewing the technology videotape (What kinds of tasks are best suited for computer use (e.g., communication, collaboration, information access, expression)? What criteria should be applied for justifying the use of a computer in a particular task (e.g., efficiency or productivity gains)?).

3. Listen to an introduction and view each segment of the technology videotape, Teaching and Learning with Technology, followed by participation in guided group discussion after each videotape segment (e.g., Which teaching practices that

use technology could you apply to your anticipated classroom setting? What do you find engaging about these uses?).

4. Participate in a follow-up activity after all videotape segments have been viewed and discussed: (a) form groups of three or four, (b) reflect on the entire videotape and identify the characteristics of the technology-assisted learning activities viewed that help students become responsible, capable learners, (c) after approximately 10 minutes, each group shares one item with the class, (d) the instructor records responses for all to see, (e) each group continues to present one item, in turn, until a sufficient number of diverse ideas have been shared, and (f) the class builds on the ideas presented and develops possible criteria to use when selecting or creating learning activities that use technology.

5. Discuss where educational uses of computer technology can go wrong and possible means of prevention (e.g., the teaching and learning process can become impersonal, students can work in isolation, opportunities for student discourse can be reduced, and opportunities to use teamwork in problem-solving can be reduced).

Learning outcome number 13. The student will display confidence in the use of microcomputers (valuing level).

Student experiences:

1. Discuss feelings about one's confidence in using computers.

2. Master word processing software to build confidence in using the computer by following these learning steps based on the mastery approach to learning developed by Block and Anderson (1975) (this experience is related to learning outcome number 9): (a) the instructor specifies an acceptable level of performance that is within reach of all students; (b) the instructor presents lesson(s) and provides for guided practice in accordance with learning outcome number 9; (c) the instructor administers a formative performance test using the computer and word processing software; (d) the instructor pairs high and low achieving students for peer tutoring during class time; (e) the instructor presents a corrective lesson to students who did not meet the criterion on the formative test, if necessary; (f) the instructor administers a summative performance test to students who did not meet the criterion on the formative test; and (g) the instructor assigns a grade of A to students who meet the acceptable level of performance on either the formative or the summative test.

Learning outcome number 14. The student will form judgments as to the major directions computer technology should move in a classroom environment (organization level)

(Learning outcomes number 8 and number 12 support this outcome.) Student experiences:

1. Identify and discuss desired shifts of emphasis from a traditional classroom to an ideal technological classroom (i.e., use of technology: shift from drill and practice to communication, collaboration, information access, and expression; instructor role: shift from fact teller and expert to collaborator and sometimes learner; student role: shift from listener and always learner to collaborator and sometimes expert; classroom activity: shift from instructor-centered and didactic to learner-centered and interactive; instructional emphasis: shift from facts and memorization to relationships, inquiry, and invention; demonstration of success: shift from quantity to quality of understanding; and assessment: shift from norm-referenced and multiple-choice items to criterion-referenced items and performances)(Dwyer, 1994).

2. Participate in an in-class cooperative learning project on the educational uses of computer technology in the content areas and/or grade levels by following these steps: (a) form small cooperative groups (e.g., 2 to 4 students each) based on content area and/or grade level of interest (e.g., primary grade level or high school math); (b) each group determines and records on paper legitimate uses of computer technology for their assigned content area and/or grade level; (c) each

group categorizes all recorded uses as "most important" or "least important;" and (d) each group presents its results to the class and leads a brief discussion.

Learning outcome number 15. The student will formulate a classroom computer technology plan in harmony with personal abilities, interests, and beliefs (organization level).

Student experience:

develop a classroom computer technology plan tailored to one's content area and/or grade level. Describe (Beichner, 1993): (a) the students one will be teaching, including social and cognitive characteristics; (b) the computer technology that will be used; and (c) how it will be used. Include justification for use of technology by drawing on student characteristics.

General Activities

Students will also experience the following general activities: (a) homework assignments (including reading pertinent portions of the textbook, preparing word processing documents, and preparing paper output of overhead transparencies); (b) periodic tests (2-4 topic tests, primarily computer-based); (c) a final comprehensive examination; and (d) stress inoculation training (Meichenbaum, 1985).

Stress inoculation training will be conducted in response to student expressions of stress during classroom

discussions. It consists of three phases. During conceptualization, the first phase, the instructor focuses on establishing a collaborative relationship with the subjects while helping them to better understand the nature of stress and its disruptive effects on behavior and performance. During skills acquisition, the second phase, the instructor focuses on the development of coping skills, such as the use of adaptive self-statements and the development of relaxation and problem-solving skills. During the final phase, application and follow-through, the instructor provides for rehearsals and exercises, as appropriate, during the normal course of classroom activities (e.g., student computer-based presentations).

# APPENDIX E

## COGNITIVELY-FOCUSED TREATMENT SYLLABUS

### Policies

Attendance: Attendance is mandatory.

Special needs: Students with special needs will be accommodated.

Assignments: All assignments are due at the beginning of the first class meeting each week. Written assignments must be prepared using a word processor and, unless otherwise specified, include a cover sheet with the following information: (a) name and student number, (b) course and section number, and (c) assignment title.

Late work: Late work will be accepted until the beginning of the next scheduled class, but will be subject to a late work penalty.

Grades: The final course grade will be based on the following equally weighted sources: (a) quizzes, (b) homework and in-class activities, and (c) final examination. All assignments will be graded based on form and content. Quiz and examination content will be based on classroom instruction and homework assignments.

### Text and Materials

Textbook: Presley, B., & Brown, B. (1995). An introduction to computing using Microsoft Works version 3 for Windows. Pennington, NJ: Lawrenceville Press.

Notebook: A notebook is required that should be organized to serve as a reference tool.

Computer disks: A minimum of two 3-1/2" disks (either double density or high density) are required. Label the disks with your name, course, and section number.

## Major Requirements

Prepare a 2-3 page report that evaluates an educational software application using the methodology covered in class. Select an application to evaluate that is consistent with the grade-level and content area that interests you the most.

Plan and conduct an ERIC database search using ODU library resources. Turn-in an annotated printout from the library printer.

Periodic computer-based topical quizzes.

Final comprehensive examination using a university blue book.

## Course Outline

| Week Beginning | Major Topics | Assignments |
|---|---|---|
| Jan 8 | Introduction, history of computers | None |
| Jan 15 | Hardware, software, and terminology | Chap. 1 |
| Jan 22 | Word processing | Chap. 2 |
| Jan 29 | Word processing | Chap. 3 |
| Feb 5 | Word processing, quiz | Chap. 4 |

| | | |
|---|---|---|
| Feb 12 | Databases | Chap. 5 |
| Feb 19 | Databases, ERIC | Chap. 6 |
| Feb 26 | Databases, quiz | Chap. 7, #1 |
| Mar 4 | SPRING BREAK | None |
| Mar 11 | Technology integration, spreadsheets | Chap. 8, #2 |
| Mar 18 | Spreadsheets | Chap. 9 |
| Mar 25 | Spreadsheets, quiz | Chap. 10 |
| Apr 1 | Desktop presentations | None |
| Apr 8 | Desktop presentations, quiz | None |
| Apr 15 | Networking and telecommunications | Chap. 13 |
| Apr 22 | Review, final examination | Note 3 |

Note #1 - Turn-in software evaluation report (on disk).

Note #2 - Turn-in annotated ERIC search (paper copy).

# APPENDIX F

## HUMANISTICALLY-FOCUSED TREATMENT SYLLABUS

### Policies

Attendance: Attendance is mandatory.

Special needs: Students with special needs will be accommodated.

Assignments: All assignments are due at the beginning of the first class meeting each week. Written assignments must be prepared using a word processor and, unless otherwise specified, include a cover sheet with the following information: (a) name and student number, (b) course and section number, and (c) assignment title.

Late work: Late work will be accepted until the beginning of the next scheduled class, but will be subject to a late work penalty.

Grades: The final course grade will be based on the following equally weighted sources: (a) quizzes, (b) homework and in-class activities, and (c) final examination. All assignments will be graded based on form and content. Quiz and examination content will be based on classroom instruction and homework assignments.

### Text and Materials

Textbook: Presley, B., & Brown, B. (1995). An introduction to computing using Microsoft Works version 3 for Windows. Pennington, NJ: Lawrenceville Press.

Notebook: A notebook is required that should be organized to serve as a reference tool.

Computer disks: A minimum of two 3-1/2″ disks (either double density or high density) are required. Label the disks with your name, course, and section number.

Major Requirements

Maintain a "Computer Likes and Dislikes Journal" in your notebook (i.e., what I like about computers, what I dislike about computers, and why). Record your feelings and thoughts about computers and any attitude changes on at least a weekly basis. Be prepared to discuss your likes and dislikes in class biweekly.

Prepare a 2-3 page report that evaluates an educational software application using the methodology covered in class. Select an application to evaluate that is consistent with the grade-level and content area that interests you the most.

Plan and conduct an ERIC database search using ODU library resources. Turn-in an annotated printout from the library printer.

Use ERIC to find an article that describes the impact of computer technology on learning or teaching in your subject/grade level of interest. Read the article and prepare and turn-in a 2 page report that summarizes the article.

Make a short presentation to the class (not more that 5 minutes) that summarizes your report on the impact of computer technology.

Develop a classroom computer technology plan tailored to your content area and/or grade level. Describe: (a) the students you will be teaching, including social and cognitive characteristics; (b) the computer technology that you will use, if available; and (c) how it will be used. Include justification for use of technology by drawing on the characteristics of your students.

Periodic computer-based topical quizzes.

Final comprehensive examination using a university blue book.

Course Outline

| Week Beginning | Major Topics | Assignments |
|---|---|---|
| Jan 8 | Introduction, hardware, terminology | None |
| Jan 15 | Software, technology integration | Chap. 1 |
| Jan 22 | Word processing | Chap. 2 |
| Jan 29 | Word processing | Chap. 3 |
| Feb 5 | Quiz, computers in education | Chap. 4 |
| Feb 12 | Databases, ERIC, quiz | Chap. 5 |
| Feb 19 | Technology case studies | None |
| Feb 26 | Technology case studies, quiz | #1 |

| | | |
|---|---|---|
| Mar 4 | SPRING BREAK | None |
| Mar 11 | Spreadsheets, quiz | Chap. 8 |
| Mar 18 | Desktop presentations | None |
| Mar 25 | Desktop presentations, quiz | None |
| Apr 1 | Student presentations | #2 |
| Apr 8 | Student presentations | None |
| Apr 15 | Networking and telecommunications | Chap. 13, #3 |
| Apr 22 | Review, final examination | None |

Note #1 - Turn-in software evaluation report (on disk).

Note #2 - Turn-in annotated ERIC search (paper copy) and impact of computers on education report (on disk).

Note #3 - Turn-in classroom technology plan (paper copy).

# APPENDIX G

## START-OF-STUDY QUESTIONNAIRE

Directions: Please complete both pages of this questionnaire by entering your replies in the spaces provided.

1. What is your name? ______________________________

Answer questions number 2 and number 3 only if you are completing this questionnaire during the fall semester. Your responses will be used to mail you your final questionnaires in March and to contact you by phone if needed to remind you to return the completed questionnaires.

2. What is your local mailing address? ____________________

______________________________________________

3. What is your local telephone number? ____________________

4. What is your sex? Male _____ Female _____

5. What is your age? __________

6. What is your present class standing? (Check one)

| | | | | | |
|---|---|---|---|---|---|
| Freshman | _____ | Sophomore | _____ | Junior | _____ |
| Senior | _____ | Graduate | _____ | Other | _____ |

7. Are you presently enrolled in a teacher education program? (Check one)

   Yes _____ No _____

8. What grade level do you teach or expect to teach? (Check one)

   Elementary ____ Middle School ____ High School ____

9. Do you presently own a computer or have regular access to a computer?

   Yes _____ No _____

10. List any course(s) you are taking this semester that require(s) you to use a computer in the classroom.

______________________________________________

11. Typically, how many total hours per week during the school year do you use a computer at school, at work, and at home? (Check one)

    0 hours per week .......................... _____
    Greater than 0 hours and
        less than 2 hours per week ............. _____
    Greater than or equal to 2 hours and
        less than 4 hours per week ............. _____
    Greater than or equal to 4 hours and
        less than 6 hours per week ............. _____
    Greater than or equal to 6 hours and
        less than 8 hours per week ............. _____
    Greater than or equal to 8 hours per week .... _____

12. How long have you been using computers regularly at school, at work, and at home? (Check one)

    Not at all ..................... _____
    Less than 6 months ............ _____
    Between 6 months and 1 year ... _____
    Between 1 and 2 years ......... _____
    Between 2 and 3 years ......... _____
    Over 3 years .................. _____

13. Please assess your <u>knowledge</u> of computers for each area described below using a scale of 0 to 3.

| <u>Scale</u> |
|---|
| 0 = no knowledge |
| 1 = slight knowledge |
| 2 = moderate knowledge |
| 3 = considerable knowledge |

    Computer programming .............. ____
    Database management programs ....... ____
    Desktop presentation programs ...... ____
    Desktop publishing programs ........ ____
    Entertainment/games ................ ____
    Graphics programs .................. ____
    Multimedia/hypermedia programs ..... ____
    Networks ........................... ____
    Spreadsheet programs ............... ____
    Telecommunications ................. ____
    Word processing programs ........... ____

## APPENDIX H

## END-OF-STUDY QUESTIONNAIRE

Directions: Please enter your replies in the spaces provided.

1. What is your name? ______________________________

2. Did you use any outside help, such as a tutor, to assist you in ECI 304?

   Yes _____ No _____

3. Did you purchase a computer since the start of this study?

   Yes _____ No _____

4. Did you use a computer at work during this study?

   Yes _____ No _____

5. Did you use a computer for another course during this study?

   Yes _____ No _____

6. If you answered yes to any of the above questions please explain your response(s) on the back side of this page.

7. Were your expectations for ECI 304 satisfied? (Check one)

   Yes _____ In Part _____ No _____

   If you answered either In Part or No to question number 7, please explain your response on the back side of this page.

8. How important is it for teachers to use computer technology in the classroom to assist and/or manage instruction? (Check one)

   Not important............. _____

   Barely important.......... _____

   Rather Important.......... _____

   Very important............ _____

   Extremely important....... _____

9. How would you presently describe <u>your intention</u> of using computer technology in the classroom to assist and/or manage instruction when you become a teacher, assuming the hardware and software you need are available? (Check one)

Not likely to use computers........._____

Barely likely to use computers......_____

Rather likely to use computers......_____

Very likely to use computers........_____

Extremely likely to use computers...._____

10. Typically, how many total hours per week during the school year do you use a computer at school, at work, and at home? (Check one)

0 hours per week ............................ _____
Greater than 0 hours and
less than 2 hours per week .............. _____
Greater than or equal to 2 hours and
less than 4 hours per week .............. _____
Greater than or equal to 4 hours and
less than 6 hours per week .............. _____
Greater than or equal to 6 hours and
less than 8 hours per week .............. _____
Greater than or equal to 8 hours
per week ................................ _____

11. How long have you been using computers regularly at school, at work, and at home? (Check one)

Not at all ..................._____

Less than 6 months ..........._____

Between 6 months and 1 year ..._____

Between 1 and 2 years ........._____

Between 2 and 3 years ........._____

Over 3 years .................._____

12. Please assess your <u>knowledge</u> of computers for each area described below using a scale of 0 to 3.

| Scale |
|---|
| 0 = no knowledge |
| 1 = slight knowledge |
| 2 = moderate knowledge |
| 3 = considerable knowledge |

Computer programming .............. ____
Database management programs ....... ____
Desktop presentation programs ...... ____
Desktop publishing programs ........ ____
Entertainment/games ................ ____
Graphics programs .................. ____
Multimedia/hypermedia programs ..... ____
Networks ........................... ____
Spreadsheet programs ............... ____
Telecommunications ................. ____
Word processing programs ____

Respond to the following question only if you took ECI 304 during the fall semester.

13. Typically, how many total hours per week have you used a computer at school, at work, and at home since completing ECI 304?

For example, if you feel that you used a computer 2-1/2 hours per week, enter 2-1/2 or 2.5 hours in the space provided. If you did not use a computer at all, enter 0 hours.

Enter number of hours per week: ________ hours

Thank you very much for participating in this study!
Please return the completed questionnaires in the enclosed envelope as soon as possible.

# APPENDIX I

## OBSERVATION FORM

1. Today's date and time: ______________________________

2. Instructor's name: ______________________________

3. Observer's name: ______________________________

4. Affective domain learning outcomes: ______________________________

______________________________________________________________

______________________________________________________________

5. Time (in minutes) devoted to affective domain learning outcomes: __________ minutes

6. Cognitive domain learning outcomes: ______________________________

______________________________________________________________

______________________________________________________________

7. Time (in minutes) devoted to cognitive domain learning outcomes: __________ minutes

8. Total time (in minutes) devoted to each teaching method:

Presentation method ....................__________ minutes

Presentation method: includes lecture (formal or informal presentation of information, concepts, or principles by a single individual, with or without questioning), panel discussion, demonstration-performance (presentation or portrayal of a sequence of events to show a procedure), reading (books, periodicals, handouts, etc.), and self-paced (programmed instruction).

Verbal interaction method ..............__________ minutes

Verbal interaction method: questioning and discussion, including guided discussion (teacher-facilitated interactive process of sharing information, experiences, and feelings) and nondirected discussion (such as peer-controlled group discussion).

Application method ....................__________ minutes

Application method: provides learners with opportunities to apply learned material, e.g., using a computer. Includes individual and group projects, case studies (including discussion), and simulations (e.g., role-playing and games).

9. For teacher-student interactions initiated by the instructor, how many were cognitive interactions (e.g., how do you edit text, who invented the computer?) and how many were affective interactions (e.g., why is this lesson important to you, how did that make you feel?)

Number of cognitive interactions .......__________

Number of affective interactions .......__________

10. Identification of computer software and hardware used by students (as appropriate): ______________________________

______________________________

11. Description of observed student experiences: __________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

12. Description of materials used (e.g., transparencies, videotape, chalkboard) ______________________________

______________________________

______________________________

Observer's signature

# APPENDIX J

## LETTER OF TRANSMITTAL

(university letterhead)

March 2, 1996

Dear study participant,

Thank you very much for volunteering to participate in educational research. We are particularly desirous of obtaining your responses on the enclosed three questionnaires. They constitute the final phase of your participation in this study. Completing these questionnaires should require eight minutes or less of your time.

Please complete the enclosed questionnaires honestly and independently as soon as possible and return them in the stamped envelope enclosed. The research report cannot be completed until we finish analysis of questionnaire data. Your responses are very important to the validity of this research effort. The information you provide will be held in strict confidence in accordance with the consent form you signed last September.

Fred Rovai, the researcher for this study, will send you a five dollar check if he receives your completed questionnaires by March 15, 1996. This token is our way of thanking you for your conscientious participation in this study.

Sincerely yours,

(department chair)

# APPENDIX K

## COURSE EVALUATION

The following information from you will be used as part of the evaluation of instruction at Old Dominion University. Please respond seriously and carefully to each of the following items. Use a pencil to record your answers. Please do not put your name on the forms. Your answers will remain completely confidential. Thank you for your cooperation.

Please describe your reaction to each of the following statements in terms of this scale.

| UNACCEPTABLE | POOR | ACCEPTABLE | GOOD | VERY GOOD | EXCELLENT |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

1. Rate the overall effectiveness of the instructor.

2. Rate the instructor's ability to communicate ideas.

3. Rate instructor's consistency/punctuality meeting class and using allotted time.

4. Rate instructor's helpfulness/sensitivity/responsiveness to all students' needs.

5. Rate the overall quality of the course.

6. Rate how much you have learned or benefited from the course.

7. Rate this course on organization, structure and clarity of requirements.

# VITA

Alfred P. (Fred) Rovai was born in San Jose, California. He earned a Bachelor's degree in mathematics from San Jose State University and entered the U.S. Army upon graduation. While on active duty he earned a Master's degree in public administration at the University of Northern Colorado, completed a graduate program in systems management at the University of Southern California, and graduated from the U.S. Army Command and General Staff College.

His significant military assignments included Chief Intelligence Officer of the 198th Infantry Brigade engaged in active combat in Vietnam; Assistant Test Manager for major Army command, control, and intelligence systems at the Pentagon; Chief of the Electronic Warfare Branch of the Joint Staff at the Pentagon; Head of the NATO Electronic Warfare Assessment Group of the International Military Staff in Belgium; and Dean of the Joint Command, Control, and Electronic Warfare School at the Armed Forces Staff College.

Colonel Rovai retired from the military in July 1990 and obtained a Master's degree in education from Old Dominion University. In the spring of 1992 he began his doctoral work in urban services while also teaching classroom management and educational technology. He presently resides at 1939 Mill Pond Drive, Chesapeake, Virginia 23320-8168.