Computer Anxiety, Mathematics Anxiety and Achievement in an Adult Basic Mathematics Course

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Abstract

This study was designed to investigate the constructs of computer anxiety and mathematics anxiety and their influence on achievement in an adult basic mathematics course. The sample consisted of 40 subjects, 18 females and 22 males. A demographics questionnaire was administered to gather information on gender, age, mathematics level, and computer experience. The Computer Attitude Scale (CAS) was used to measure computer anxiety, computer confidence, computer liking, computer usefulness, and computer attitude and the Mathematics Anxiety Rating Scale was used to measure mathematics anxiety. No significant interaction effect was found on mathematics achievement between computer anxiety and mathematics anxiety. Computer attitude was not supported as having a significant relationship with mathematics achievement. Significant gender differences were found across computer attitude and all of the CAS subscales. Women exhibited more negative attitudes and higher computer anxiety. Significant gender differences were also found for computer experience. The computer anxiety subscale was found to have a small positive correlation with two of the computer experience measures.

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Chapter 1

Introduction and Background to the Study

Contemporary Society is in a state of rapid and profound change. The results are evident in almost every aspect of human life. Manufacturers, designers, and inventors strive to create more efficient means of expediting tasks from the most mundane to the very complex. One of the most influential change factors Western society has recently experienced is the advent of computer technology. This medium has advanced to the point where standards of modern life have become defined by the technology associated with the ease and comfort of living and conducting business. An individual, or a society, is a reflection of the technology which he or she possesses.

The competitive nature of people has taken computer technology to heights which places some limitation on personal freedoms. Private lives take a subordinate role in a hierarchy when gaining information through technological devices may determine the position one holds in society. Privacy, in this sense, is no longer of the essence when progress hinges on communication. It is not acceptable in advanced society to receive messages days, hours, or even minutes late. Personal communication devices such as pagers, cellular telephones, and computers are an example of the direction modern life has taken. Power and potential are determined by the speed in which information can be passed on and processed. The central mediator of this flow of information is computer technology.

Ramifications of the ability to transfer information quickly extend to both business and academic settings. Demands for skills to use computers to this extent create a cyclic trend in which schools use available technology to prepare students in response to future expectations of occupations. Companies which process information rapidly can provide goods and services at a competitive rate to meet demands of consumers. Academic institutions use computer technology to accelerate the learning process by which skills and knowledge bases are acquired and communicated. Some academic programs directly incorporate computers into their curricula while the business community utilizes them in order to maintain or acquire a competitive edge. Computer knowledge has become a necessity because of demands placed on individuals who seek employment after their academic careers. Many occupations require some computer skills. To accommodate this demand it becomes the obligation of educational institutions to prepare their students; otherwise, these institutions may suffer loss of enrollment if programs do not satisfy the needs of those seeking further education.

In most cases technology is used to simplify, save time, and save effort; the greater picture being a society in which attention is directed towards convenience and productivity. Trends, in general, have been in the direction of technological advancement to reach the end goal of ease in administration of common tasks. Many people, institutions, and organizations embrace this progress to create environments more pleasing and efficient to both employees and consumers. A broader view maintains that computers provide a medium in society which aids daily activities. Not all individuals, however, willingly accept such rapid change into their lives.

Effects of Change

Progress presents many new challenges which require learning and mastery. This may require certain competencies not readily available in a person's repertoire and may necessitate a change in activities or skills which have become almost habitual. As is the case with most habits, they are hard to break. Many people are pleased with convenience and saving time, yet there are those who do not wish to learn new tasks when their habits have already become comfortable; that is, some individuals prefer to remain with the familiar rather than confront new tasks which, in themselves, are sources of stress. In the working world this may inhibit individuals from advancing through promotional stages in their occupations. In some situations people may find that no viable alternatives exist other than accepting the challenge of confronting technology or avoiding and rejecting it. Computers present a novel medium in an occupational or academic environment; accepting the challenge of learning and implementing new skills necessary to cope with such technological advancement will inevitably produce anxiety for some people. In order to better understand the concept of anxiety in relation to computers it should be identified as a specific form of anxiety and not a separate form of free-floating anxiety. Accordingly, research efforts need to be directed toward computer use and the anxious experience.

The unprecedented rate of technological progress creates anxiety through the uncertainty of not knowing what changes may occur in the near future following the implementation of already new materials. Rapid advancement is such that what once was leading edge technology may be obsolete six months following its introduction in the consumer industry. Equally vexing is the knowledge necessary to utilize and incorporate these changes without detriment to the established framework. Individuals need a foundation of knowledge which can be continually developed by updating information. Computer use has become such an important component of contemporary communication and industrial systems that most occupations require some type of associated skills. As a result of the Information Age, computer knowledge is an almost essential requirement for an individual's future employment marketability. Pressure to perform competently in such environments results in a great challenge for individuals pursuing careers; that is, the constant development and change of computer technology makes it difficult to maintain the high standards of mastery expected in many occupations. Consequently the influence of computer anxiety may be a significant factor in the prosperity of a society as it may limit people's achievements and their potential for success.

In response to demands for fundamental knowledge of computer technology, academic and technical institutions have acted to meet future requirements of both the students and schools. Recently, these institutions have introduced computers and computer science classes to acknowledge necessary changes in the curricula. Two modes of utilization are computer-assisted and computer-managed instruction courses. The first mode incorporates the aid of computers for instruction or presentation of materials to be learned. In the latter mode, computers record the learning progress of students and classes via student-computer interaction. The use of computers in the classroom environment may well create an atmosphere conducive to computer anxiety.

Significance of the Study

The incorporation of computers as educational tools in academic environments gives rise to many questions. An important issue to examine is the effect of related computer anxiety on advancement in academic endeavours, which may later have ramifications on progress in a career. During a student's academic career, the problem of computer anxiety is relevant to progress through its potential relationship with achievement in courses. Although computers are meant as a benefit to students, there is a possibility that performance or achievement may be negatively influenced by their presence. Some individuals may experience computer anxiety resulting from interactions with this technology or merely by their existence in the environment. These negative effects may place students at risk of severe limitation on future potential through course choice. Low grades and course selection influence a student's repertoire of experience which will determine the individual's marketability. Rosen and Maguire (1990) report that people with debilitating levels of computer anxiety perform more poorly, take more time, are not comfortable, and make more mistakes during computer tasks than those who do not experience high computer anxiety. This could increase the likelihood for avoidance of classes incorporating computer technology or enrollment in programs may drop due to computer requirements, thus narrowing the field of future work prospects. At this stage, an individual's future options begin to be moulded since career potential is founded upon the knowledge base and communication skills acquired. A cursory view of computers in education and business illustrates the importance of research on computer anxiety.

The consumer industry is an important source for public awareness of computer technology through business transactions. Common experiences may involve electronic cash registers and hand-held calculating machines. Most interactions with computers serve mathematical functions in business and home settings. Hence, an association between computers and mathematics is understandable considering the infusion of this technology into society.

Educational institutions follow a similar path since computer technology was introduced into academic environments through mathematics departments (Rosen & Maguire, 1990). This has developed to the point where many departments, in both sciences and arts, incorporate a knowledge of computer use into their curricula. As the evolution of computer technology continues and more areas of educational programs adopt these modern instruments it may become evident that a population exists which displays phobic behaviours or resistant behaviours to computer technology in the classroom.

Computer Technology in Mathematics

Mathematics skills are a requirement for students graduating from high school. The inherent link between computers and mathematics may evidence debilitating anxiety if computers are to be made functional components of the curriculum; that is, computer anxiety may be experienced by students if computer interaction is required for course completion. The vast amount of research in the field of mathematics anxiety leaves no question as to its existence. A negative relationship between mathematics achievement and mathematics anxiety was reported by Tocci and Engelhard (1991). This supports the idea of an already existing issue in the area of mathematics. To implement computer technology adds a component which is itself relatively new to society and may only further complicate the learning process for students. The concept of computer anxiety is not fully understood and raises some query as to its effects in a mathematics environment. Technology should not be haphazardly placed into the mathematics curriculum without due caution. For those students already experiencing mathematics anxiety, computers may only present a new form of anxiety. The potential for an interaction of the two constructs may place students at risk relative to achievement. This study investigated the constructs of computer anxiety and mathematics anxiety and their influence on achievement in a pre-requisite adult basic mathematics course.

The Nature of Computer Anxiety

Research into the nature and effects of computer anxiety has yet to establish fundamental characteristics of the experience. The study of this particular construct is still at a formative stage and a commonly accepted theoretical foundation is not apparent in the available literature to date. It is therefore best to consider a theory from an orientation which most closely describes the occurrence of computer anxiety. This will help form a clearer understanding of its workings and its possible role in advancement. Evidence of theory in current literature is found only through the instruments chosen for data collection and the theoretical foundation upon which they were developed.

For the purposes of this study the cognitive-behavioural approach to anxiety was used because it is grounded in a thought-behaviour relationship. More precisely, the processes by which the individual thinks, judges, and analyses information (internal and external) determines his or her actions and reactions. Simply put, cognitive processes alone do not influence an individual's thoughts; they are also under the influence of affective states. With respect to computers, it may be assumed that changing negative cognitions toward computers lower computer anxiety and, in doing so, decrease related off-task (aversive) behaviours.

This approach contends that cognitions are pursuant to the individual's interpretation and evaluation of an event, situation, or specific stimulus. Some theorists hold to Ellis' view of anxiety as stemming from an unrealistic appraisal of a situation (Goldfried, 1979). Similarly, Beck describes anxiety as a resultant of how individuals perceive and structure an experience (Corey, 1996). The recurring theme among cognitive-behavioural theorists contends that behaviour is under the auspices of thought(s) related to experience. Behaviour is influenced through cognitions which reflect evaluations from experiences of a direct or vicarious nature.

Cognitions from past experience, be it hearsay or personal involvement, may be evoked through current situations. If these thoughts are negative in nature they may influence behaviour such that performance is below what is expected or avoidance of the endeavour may occur. Prior knowledge could influence performance involving computer technology due to a bombardment and repetition of negative thoughts. Even before an individual undertakes a particular task, thinking about a pending interaction with technology may be sabotaged, as may any future interaction. Ultimately, a chain of events might take place from the thought to the experience of which computer attitude is reflected in performance and achievement.

The definition of computer anxiety in this study is adopted from Weil, Rosen, and Wugalter (1990) who define it as: "(a) anxiety about present or future interactions with computers or computer-related technology; (b) negative global attitudes about computers, their operation, or their societal impact; or (c) specific negative cognitions or self-critical internal dialogues during present computer interaction or contemplating future computer interaction" (p. 362). This definition was chosen because it encompasses the cognitive aspect of covert functioning which translates into potential behaviour students may exhibit in an academic environment.

Computer Anxiety and Mathematics Anxiety

A reasonable assumption is that computer anxiety and mathematical anxiety share a relationship. Since mathematical analogies are directly involved with technology, not only for performing tasks but also with respect to designing program languages, one can understand a link between the two anxieties. That is, since mathematics is inherent to the fundamental processes of computers, the notion of computer anxiety and mathematics anxiety being related is a logical assumption. Campbell (1988), in fact, makes a case for a relationship between computer anxiety and the perception of a relationship between mathematical ability and computer ability. She suggests that adolescent students who perceive computer ability to be unrelated to mathematics ability are inclined to have lower levels of computer anxiety than those who believe the two abilities to be related.

Indeed, much of the available research provides supportive evidence of a relationship between computer and mathematics anxiety. Lindbeck and Dambrot (1986) report low mathematics ability is related to computer anxiety and negative attitudes.

Furthermore, Igbaria and Parasuraman (1989) suggest mathematics anxiety contributes to computer anxiety, which they support as having a significant negative effect on microcomputer attitude. This is subsequently supported by an indirect relationship found through the work of Morrow, Prell, and McElroy (1986). They contend that although mathematics anxiety did not add significantly to the variance of computer anxiety, it had a significant relationship with computer experience, which did add to the variance. Additionally, Gressard and Loyd (1986) and Kernan and Howard (1990) provide evidence supporting a moderate positive relationship between mathematics and computer anxiety. This association should not, however, be assumed to be a strong direct relationship; reports either suggest a weak positive correlation or an indirect relationship (Gressard & Loyd, 1986; Igbaria & Parasuraman, 1989; Morrow *et al.*, 1986). Munger and Loyd's (1989) study provides an example of the indirect nature. Their work indicates calculator attitudes and computer confidence have a statistically significant relationship with mathematical performance, as measured by scores on a General Educational Development mathematics test. This suggests that there are some common factor(s) underlying computer attitudes and attitudes toward mathematics. Lindbeck and Dambrot (1986) report findings on a training workshop for overcoming computer and mathematics anxiety. The assumed relationship between these constructs is grounded on ability. Results suggest that subjects with higher ability hold more positive attitudes toward mathematics and computers. A logical hypothesis is that lower levels of computer and mathematics anxiety are associated with higher mathematics ability levels. Campbell's (1988) support for this is based specifically on perceptions of ability. That is, "Computer anxiety tends to have small, positive correlations with the students' perceptions of the relationships between computer ability with math ability or gender" (p. 115). Campbell explains further that those who consider these abilities as unrelated would likely have lower levels of computer anxiety. This would conceivably be reflected in mathematics achievement scores when computers are involved in a mathematics course. Other data support a more specific relationship between mathematics anxiety, computer attitude and computer aptitude such as Dambrot, Watkins-Malek, Silling, Marshall, and Garver (1985). They investigated the relationship of gender differences in computer attitude and computer aptitude among several other variables including mathematics-based concepts. Their findings indicated a relationship between mathematics anxiety and computer attitude based on correlational analyses. The trend in the available literature is indicative of a more direct relationship between the concepts. Similarities between computer anxiety and mathematics anxiety become more evident when examining groups focused on tasks incorporating mathematical procedures with computers in a particular setting. Parasuraman and Igbaria (1990) found a statistically significant relationship between the two anxiety constructs through research conducted on a group of Master of Business Administration (MBA) students who were concurrently employed full-time in various managerial positions. This research concluded that there is a positive relationship between mathematical anxiety and computer anxiety. However, these constructs only share similarities and are not analogous to one another. Also, the importance of the relationship with respect to progress in an academic environment needs to be emphasized.

Research Questions

The major questions addressed by the study are as follows:

1) What is the relationship between computer anxiety and achievement among students in an adult basic mathematics course?

2) What is the relationship between mathematics anxiety and achievement among students in an adult basic mathematics course?

3) Is there an interaction effect between computer anxiety and mathematics anxiety with mathematics achievement as the dependent variable?

4) What are the effects of computer attitude on mathematics

achievement in an adult basic mathematics university course?

A number of secondary questions regarding the relationships between computer anxiety, gender, and computer experience were also explored.

Limitations

Some limitations result from the non-random selection of subjects and the course in which they registered. Although there is a similarity between mathematics sections (Trigonometry/geometry and algebra) there may be limitations to some of the results due to individual differences of relative mathematical skills. Some students may excel in one but not the other section. Students may select a course section based on the strength of their skills in that particular area of mathematics. For students enrolled in both sections final grades were averaged to obtain an achievement score. Thus, specific proficiencies in mathematics may influence achievement scores relative to others in only one section. Since participation in the course is voluntary it is possible the group may be skewed with respect to computer anxiety and mathematics anxiety. Individuals may have sought this course out of necessity (to attend university), not having previously completed high school mathematics because of already existing mathematics anxiety. Such a specific group makes generalization to other mathematics courses and populations difficult.

Chapter 2

Literature Review

Introduction

This chapter begins with the constructs computer anxiety and mathematics anxiety because these are the primary issues under study. Other topics included range from possible links of computer anxiety to mathematics, influences of situational events as opposed to internal (cognitive) workings, individual differences (e.g. gender and experience), and sex-role identity. Some literature was excluded from this review because of differing demographics in the samples.

Mathematics Anxiety and Achievement

Research suggests that higher mathematics anxiety is consistently associated with low performance on mathematics achievement tests. Hembree (1990) conducted a meta-analysis, based on the results of 151 studies, to assimilate findings of research on mathematics anxiety. This study focussed on the nature, effects, and relief of mathematics anxiety. Criteria for inclusion in the meta-analysis were: product-moment correlations and sample sizes or enough data for effect-size calculations; the use of validated mathematics anxiety instruments; experiments used a minimum of two groups, including a control group; and experimental groups had a minimum of 10 subjects. His analysis supports the notion that mathematics anxiety reduces performance on mathematics achievement tests.

Also, although higher levels of mathematics anxiety were reported by female high school students, this did not seem to be reflected in lower performance or greater avoidance of mathematics than the equivalent male population. Hembree (1990) explains this as more of a willingness for females to express their anxiety or better coping skills in the female population.

Support for an inverse relationship between mathematics anxiety and achievement is provided by Tocci and Engelhard (1991). Their study also provides evidence supporting gender differences on the anxiety construct; females expressed higher levels of mathematics anxiety than males. This work was conducted in two countries (United States and Thailand) on a sample of 13 year old students. Their findings support mathematics anxiety as an influence on achievement in mathematics. Due attention is warranted because achievement scores may be under the influence of more than one factor.

According to results from Green (1990) only a portion of variance in mathematics achievement is due to mathematics anxiety. Her study set out to examine the relationship between test anxiety, mathematics anxiety, teacher's comments, and achievement in an undergraduate remedial mathematics course. These components were selected to investigate students' relative motivation. The sample consisted of 132 students. Results indicate 17% of the variance in course grade was due to the full range of variables, of which mathematics anxiety contributed 13% to the whole.

Computer Anxiety and Achievement

Vogel (1994) examined differences in performance between computer administration and pen-and-paper administration of the verbal section of the Graduate Record Examination. No significant main effect was reported for test mode and computer anxiety did not significantly affect the performance of the subjects across the test modes. However, there was evidence supporting an interaction between computer anxiety and test mode. Differences in performance across test modes were significant between low, middle, and high computer anxious groups. Here findings suggest that, although administration mode did not have an overall effect, different levels of computer anxiety influenced performance.

Whether there is an indirect or direct relationship between these variables has yet to be established. Szajna and Mackay (1995) addressed this concern by trying to establish a causal relationship through path-analytic procedures. The subject sample consisted of 63 undergraduate business students in a software training environment. A path model was developed to examine potential predictors of learning performance as measured by competency on database and spreadsheet programs. Computer aptitude was found to be directly related to learning performance, however, there was no evidence supporting a direct relationship between learning performance and computer anxiety. Contrary to Szajna and Mackay (1995), an inverse relationship, $r(51) = -.38$, $p < .01$, between computer anxiety and achievement was reported by Hayek and Stephens (1989). Their work investigated factors affecting computer anxiety across two high school computer science courses. Findings were based on the performance of 52 students, measured by final course grades.

Reed and Overbaugh (1993) found no significant relationship between computer anxiety and performance in their examination of different instructional formats used to reduce computer anxiety. They explained that mastery of course material might not have been challenging enough to distinguish different levels of the construct. Munger and Loyd (1989) also investigated a possible relationship of attitudes toward computers and calculators on performance; however, their measure was on mathematical performance. There were 60 high school students, enrolled in a two week enrichment course, who participated in the study. Results did not support the predictive validity of computer anxiety on mathematical performance. Munger and Loyd (1989) suggest insignificant findings on computer attitudes, in general, may be due to computer technology no longer being assumed as a specific proponent of mathematics and science.

Computer Anxiety and Gender

Munger and Loyd (1989) cite some literature reflecting the historical gender differences pertaining to attitudes and mathematics achievement. Generally, women were a minority in scientific disciplines. Although gender equity is growing, recent evidence suggests that males are still more numerous in computer science. Chen (1986) states, "It is common to find more males than females, in various age groups, taking computer classes, attending computer camps, and indicating greater interest in computers in both home and school settings" (p. 265).

Igbaria and Chakrabarti (1990) reported a statistically significant gender relationship with computer anxiety. Their conclusions are based on 187 successfully completed questionnaires, of which 32% were female respondents. Other literature supports a gender difference in attitude, with respect to computer involvement. Across these measures, Dambrot *et al.* (1985) report a small but significant gender difference. Their work was done with a relatively large sample consisting of 559 females and 342 males. Pope-Davis and Twing (1991) did not find statistically significant results to support a gender difference in their study of attitudes regarding computers. Data analyses were conducted on 207 questionnaires used to investigate the possible effects of age, gender, and computer experience on computer attitude. If one accepts computer anxiety as a component of computer attitude, Gilroy and Desai (1986) offer support for gender differences. Their findings indicated gender as predictive of computer anxiety.

Other studies fail to corroborate findings of gender differences on the variable of computer anxiety. Dyck and Smither (1994) reported a significant negative relationship between computer anxiety and computer experience in both male and female groups. However, correcting for the factor of computer experience revealed no gender difference in computer anxiety. Todman and Monaghan (1994), in fact dropped gender out of their path model since it did not significantly relate to any of the variables in their study. Equally, Henderson, Deane, Barrelle, and Mahar (1995) did not find any significant relationship between computer anxiety and gender in their study which was conducted on 253 health care and banking employees.

A meta-analysis conducted by Rosen and Maguire (1990) revealed small, but inconsistent, differences across the genders. Inclusion in their study was evaluated by the following criteria: research was empirical involving numerical data; a minimum of 20 subjects were reported; the research was published in either a professional journal, appeared in a published book, was part of a doctoral dissertation, was a document listed in the Educational Resources Information Center.

Rosen and Maguire (1990) comment on a belief reflected in non-empirical literature which characterizes females as computerphobic. Although this may be an extreme expression, it creates an impression of higher computer anxiety in the female population. This, however, received little support from findings of their meta-analysis. Rosen and Maguire (1990) further suggest it may be more beneficial to conduct research in the area of sex-role differences as opposed to gender differences.

Colley, Gale, and Harris (1994) reported findings supporting an association between lower computer anxiety and masculinity among females. Importance of gender-stereotyping is highlighted in this article as a consideration in the context of society and gender role socialization. That is, how computers are perceived by individuals in society may be established by the manifestation of gender-specific stereotyped behavioural traits. It is interesting to note the implications of these studies. They are indicative of the encouragement males receive towards scientific endeavors and the lack of this same encouragement for females.

On a related trend to external sources influencing computer use and anxiety, Chen (1986) accounts for differences in computer experience through the social influence of peer groups. His findings suggest males have a stronger presence of significant others within the body of their peer group that act as influences on their own computer use. At-home use of computers might be increased not only through parental influences but also from the peer group.

Gender differences in determinants of computer anxiety and computer attitudes were examined by Parasuraman and Igbaria (1990) with respect to specific occupational roles. They investigated whether these differences existed at a managerial level. Computer anxiety was examined on compositions of individual differences and relative relationships among them. Attitudes toward microcomputers were studied with respect to these individual differences including computer anxiety. A survey was distributed to 210 people in an MBA program, who were also employed full-time by a variety of organizations. Data were gathered and analysed on 166 usable questionnaires. Results indicated no gender differences in computer anxiety and computer attitudes toward microcomputers. There was, however, statistical support for gender differences on four individual difference variables. Firstly, female managers were younger than male managers. The second variable, education, indicated lower levels among the women than men. The third measure, which females in the study showed significantly higher levels, was on external locus of control. Lastly, female participants had lower scores than male subjects on the feeling-thinking dimension of cognitive style. Because of these differences separate regression analyses for the genders were conducted. These helped determine the significance and composition of relationships of individual differences with computer anxiety and computer attitudes. For the male managers, 37% of the variance in computer anxiety was explained by personality and demographic variables. Determinants of computer anxiety among the female managers were not found to be statistically significant. Results on attitudes toward microcomputers indicate individual differences accounted for 26% of the variance among male managers and 38% among female managers. Parasuraman and Igbaria (1990) suggest lower age and education of female participants may provide some explanation for gender differences on the individual variables. Such that younger, less educated females may not have the developed confidence of older males with more education. Thus, the higher level of external locus of control found in the female managers.

Computer Anxiety and Experience

The old adage "Practice makes perfect" comes to mind when debating whether experience is always, irrevocably a positive factor in decreasing computer anxiety. In fact, some research indicates that over time there will be less need for computer anxiety testing as computers become more embedded into public life (LaLomia & Sidowski, 1993). A commonly held myth, in this respect, is that experience will improve or cure computerphobia (Rosen & Maguire, 1990). Yet, current literature disputes this notion, such that some individuals will remain anxious despite exposure or may suffer an increase in this anxiety (McInerney, McInerney, and Sinclair, 1994; Weil *et al.*, 1990).

Computerphobics (sweaty palms, heart palpitations, or self-dialogues about incompetence) and uncomfortable users (range from slight anxiety or negative cognitions to higher computer anxiety) rate their first experience with computers as more negative than non-computer anxious individuals according to Weil *et al.* (1990). Their results indicate that a more significant experience with computers is likely to occur after the first encounter. It is not necessarily the initial encounter which dictates later reactions and thoughts towards computers. Rosen and Maguire (1990) develop this idea of computer interaction and suggest, "Even when a computerphobic has a successful computer experience anticipation of the next experience is engulfed in a complex of negative psychological reaction. It is those negative anticipatory responses that must be eliminated" (p. 187). Further, the element of evaluation or pressure to perform, with respect to experience, has been associated with computer anxiety (Weil *et al.*, 1990). Todman and Monaghan (1994) reported a statistically significant relationship between age of first experience with computers and the evaluation, by the individual, of that experience as relaxed or tense. They suggest early computer experience results in a "greater tendency" to use computers and anticipate future use. Based on their findings, adults who had early exposure to computers should experience lower levels of computer anxiety than people who encounter them later in life. Support is provided for the notion of the positive role computer experience has on computer anxiety by Morrow *et al.* (1986). Their research examined ten potential correlates of computer anxiety. Various multiple-item questionnaires were administered to 174 undergraduate college students. Based on these data, a regression analysis was conducted on computer anxiety and its potential correlates: computer knowledge, locus of control, computer experience, ownership avoidance, automatic bank-teller card use, rigidity, math anxiety, typing speed, video game ownership, and video game avoidance. Only three (computer knowledge, locus of control, and ownership avoidance) of these variables made statistically significant impact on the variance. Three correlates plus computer experience accounted for 31% of the variance. The six other variables only made up 5% of the variance. Self-reported behaviours such as computer experience, knowledge, and ownership avoidance fell within the greater amount of shared variance. Personality and attitudinal correlates were found to account for a very small factor of explained variance. Morrow *et al.* (1986)

suggest computer anxiety may be a resultant of prior experiences rather than strong attitudes toward computers or a personality trait. All of this, of course, is founded on a supposition that computer anxiety is influenced by computer experience. Many studies report a significant negative correlation. Fariña, Arce, Sobral, and Carames (1991) reported subjects with more experience had lower levels of computer anxiety. This study examined predictors of anxiety towards computers and 162 university students participated.

Colley *et al.* (1994) studied gender role identity and experience on computer attitude. Undergraduate students took part in this study to compile a total of 160 participants. Results indicated that computer experience had a significant negative relationship with computer anxiety for both genders. Crable, Brodzinski, Scherer, and Jones (1994) add support to this finding in their study on computer anxiety of novice users. Their sample consisted of 425 graduate and undergraduate university business students. The researchers defined experience as the amount of exposure to computers. Their findings suggest exposure had slight importance in predicting computer anxiety. A number of other studies on graduate and undergraduate students corroborate these findings for a negative correlation between experience and computer anxiety (Cohen & Waugh, 1989; Dyck & Smither, 1994; Igbaria & Chakrabarti, 1990).

In the process of developing and validating a computer anxiety rating scale, Heinssen, Glass, and Knight (1987) similarly reported a negative relationship between the variables. There is sufficient evidence indicating no relationship or a positive relationship to cast doubt on what some may deem as a concrete correlation. Pope-Davis and Twing (1991) investigated the effects of experience, among other variables, on measures of attitude regarding computers. Their sample consisted of 207 students participating in a computer skills course offered at a college. Results from an analysis of variance of computer anxiety by age, gender, and computer experience indicated no significant interactions or main effects. Thus, Pope-Davis and Twing (1991) offered no support for a negative relationship. Rosen and Maguire (1990) concluded that computer experience may increase avoidance of computers rather than decrease computer anxiety when the exposure is negative in nature. This notion is indirectly supported by a study which reports an occupation group with more computer experience indicating higher levels of computer anxiety than a group with presumably less experience (Henderson *et al.*, 1995). In this study banking employees indicate more computer anxiety than students. Assuming computer experience is higher for banking employees, because of the nature of their work, one would expect to find computer anxiety to be lower in this group. This however, was not the case.

Chapter 3

Methods

Introduction

This research was conducted at an academic institution in Western Canada. The subject group consisted of 42 students enrolled in an adult basic mathematics class. Subjects were in either a trigonometry/geometry section, an algebra section, or both. Each course was separated into units and approximately ten computer-generated tests were associated with the individual sections in a unit. The course fulfilled minimum requirements allowing students to enter further university level mathematics courses. Presentation of the curriculum within these classes was designed as a computer-managed course. Instruction and assistance was provided by the course instructor. Computers were used to produce relevant test questions and monitor students' progress through the duration of the semester.

In order for students to advance from one unit to the next they were required to demonstrate sufficient mastery of mathematics skills by completing all computer-generated and scored mathematics tests corresponding to the unit sections. This required the individual student to input data (answers to questions posed) on a computer. If the student scored 80% or higher, he or she was able to proceed to the next unit section in the curriculum. This allowed students to advance at their own pace. In order to write the final examination (pen and paper format) each pupil was required to complete a minimum of five out of a possible six two week units.

Students may have entered their classes with pre-existing levels of anxiety for mathematics, computers, or both. Therefore, subjects were measured on each anxiety. Every participant completed a demographics questionnaire, Computer Attitude Scale (CAS), and the Mathematics Anxiety Rating Scale (MARS). When high and low mathematics anxious students were identified they were treated as separate groups within the design of the study. This study is a correlational design which highlights the relationship between computer anxiety, mathematics anxiety and achievement in mathematics.

Sample

The subjects of this study constituted an opportunity sample since they were part of an intact group already enrolled in an introductory mathematics course. Two individual sets of data were discarded since achievement scores could not be obtained for them. Of the remaining 40 participants, 18 were female and 22 were male.

Based on the descriptive results, groups were divided relative to computer anxiety and mathematics anxiety. Median splits on the computer anxiety subscale (CAS_A) and Mathematics Anxiety Rating Scale (MARS) were used to distinguish high and low anxiety groups. Any subject scoring lower than 34 on the CAS_A was designated as high in computer anxiety, while any scores above were placed in the low computer anxiety group. The same was done on the MARS; any scores below 175 were assigned to the low mathematics anxiety group and above this median was considered high in mathematics anxiety. That is, four groups were established: low computer anxiety, high computer anxiety, low mathematics anxiety, and high mathematics anxiety. As well, groups identified as low and high in computer attitude were also established using a median split on the CAS (138). The negative computer attitude group consisted of those falling beneath the median and the reverse for those in the positive attitude group.

Instruments

Demographics Questionnaire

A demographics questionnaire was administered to collect information on gender, age, prior computer experience, and current level of mathematics. Computer experience consisted of five measures: computer ownership (CEA), computer access (CEB), computer use in hours per day and week (CEC), computer use in months and years (CED), computer expertise (CEE), and relevance of knowledge about computers to the individual.

Computer Attitude Scale

The Computer Attitude Scale (CAS), Loyd and Gressard (1984), was selected for the purpose of this study because of its stability over the total measure of computer attitude and four subscales. The instrument consists of 40 items and is scored on a one to four Likert-type scale, ranging between strongly agree and strongly disagree. There are four subscales: Computer Anxiety (CAS_A), Computer Confidence (CAS_C), Computer Liking (CAS_L), and Computer Usefulness (CAS_U). Total scores, ranging between 40 and 160, are calculated by adding the subscale scores. Higher ratings on an overall score indicate positive general attitudes towards computers. Scores on the subscales range from 10 to 40 with ratings corresponding to higher and lower degrees of anxiety, confidence, liking, and usefulness. With the exception of computer anxiety, higher scores reflect higher confidence, liking and belief of usefulness. Higher scores on the CAS_A reflect lower computer anxiety. Coefficient alpha reliabilities ranging between .82 and .95 are reported by Loyd and Loyd (1985). Intercorrelations of the subscales range between .36 and .83. There is enough common variance among the factors (anxiety, liking, and confidence) allowing the assumption of a representative total score (Loyd & Gressard, 1984). The subscale of usefulness was a later addition to the CAS. Its high correlation with the total is sufficient to justify its incorporation. Also, Loyd and Loyd (1985) comment on a suitable variance to distinguish it as a separate score; that is, separate scores are representative of the individual subscale measurements and a total indicates a general attitude towards computers and computer use.

Mathematics Anxiety Rating Scale

The Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn (1972) is a much utilized instrument for measuring mathematics anxiety. It consists of 94 items and its one to five scale ranges between responses of not at all and very much. Internal consistency of the instrument is very high with a coefficient alpha reported at .97 (Kline, 1978). Test-retest reliability was measured on two groups of college students with a duration of two and seven weeks passing between administrations. Results were acceptable at .75 and .85, respectively (Kline, 1978).

Achievement

Achievement (FP) was measured by the final percentage grade students received in the course. These marks were established by combining 50% of a final comprehensive examination mark, 15% of a mid-term examination mark, and 35% of a term mark. The term mark was based on the results of successfully completed computer-generated tests. No student was allowed to write the final exam if a minimum of 83% (5/6) of the units in the curriculum were not completed.

Some students belonged to both sections of the mathematics sections (trigonometry/geometry and algebra). An average between the final marks received was taken as a measure of achievement for these students. In most cases the difference in score was one to five percent. However, there was one subject with as much as a ten percent difference in final grades.

Method of Data Collection

Data collection took place during the first two weeks of March 1997. Testing needed to be conducted during the semester when normal levels of anxiety would be experienced. Therefore the beginning of March was selected as an appropriate time. It followed mid-term examinations and was not close to the final examination period. Ethical Clearance was granted by the Research Ethics Review Committee of the University (Appendix I). Verbal permission to gain access to student's final grades was obtained by the Registrar, University Entrance Program department, and written consent from the students. A copy of the consent form which the students completed is provided in Appendix II.

Students were informed about the purpose of the study and their role as participants. An explanation was provided that participation was voluntary; refusing to take part would not influence their grade or standing at the institution. They were also informed of their anonymity and the confidentiality involving results. A verbatim script of the verbal information is provided in Appendix III.

After being informed and before they filled consent forms, participants were invited to ask any questions they might have had. Although 45 minutes was allowed to complete the questionnaires, most volunteers finished the forms within half an hour. A majority of students attended two formal sessions during normal class time. Approximately four subjects completed the forms outside of these sessions due to time constraints.

Data Analysis

Descriptive statistics consisting of means and standard deviations were calculated for variables outlined by the format of the testing instruments. Pearson *r* coefficients were calculated to determine the correlations between variables. Independent *t*-tests were conducted between sub-groups of anxiety based on gender, anxiety, experience and attitude. A One-Way Analysis of Variance was conducted on CAS_A by CEC. And, upon the results, a One-Way Analysis of Covariance with a covariate of CEC was preformed to account for experience (in hours per day) across genders on the measure of computer anxiety. A 2 x 2 Analysis of Variance was done to test for significant interaction effects of computer anxiety and mathematics anxiety on achievement.

Chapter 4

Results

Descriptive Statistics

Table 1 provides a summary of the group demographics. As can be seen, the male 16-24 category is the largest subgroup in the sample, which represents 28% of the entire group. The largest portion of the overall sample is also in this category. A fair balance between genders is evident with females accounting for 45% of the total. Of the participants, a strong majority completed grade 12 and 11 mathematics, if not actually having mathematics skills exceeding the grade 12 level. Also, 58% of the subjects reported owning their own computers. These individual differences may help explain some of the computer anxiety and mathematics anxiety scores.

The distribution of responses for computer use suggests males spent more time on computers. However, for this sample, the number of males and females are equal in the group who have been using computers for six months or less. For those with six months or more experience, males slightly exceed the number of females. Males also consider themselves more experienced as a group, with some males having programming abilities.

Table 2 provides a detailed presentation of mean computer anxiety scores across the entire subject pool, gender, highest mathematics grade level (grade level), and a self-evaluated

Table 1

Demographic Characteristics of the Sample

	Male	Female	Totals
Age Category			
Years			
16-24	11	9	20
25-30	5	2	7
31-35	2	2	4
36-40	3	3	6
41-45	1	1	2
missing data	0	1	1
totals	22	18	40
Grade Level in Mathematics			
Grade			
9	1	1	2
10	6	1	7
11	8	6	14
12	4	7	11
Exceeding Grade 12	3	2	5
missing data	0	1	1
totals	22	18	40
Computer Ownership			
Yes	14	9	23
No	7	8	15
missing data	1	1	2
totals	22	18	40

Table 1 (cont.)

	Male	Female	Totals
Computer Access			
Yes	21	16	37
No	1	2	3
totals	22	18	40
Computer Use per week			
less than one hour	2	1	3
2-4 hours	4	12	16
4 or more hours	8	3	11
more than one hour a day	8	1	9
missing data	0	1	1
totals	22	8	40
Computer Use			
less than 3 months	3	3	6
3-6 months	4	4	8
6-12 months	2	3	5
two years or more	13	8	21
totals	22	18	40
Consider Myself			
inexperienced*	2	2	4
novice learner*	10	12	22
competent*	7	4	11
expert*	3	0	3
totals	22	18	40

* inexperienced: have not used any software/computer applications
* novice learner: am familiar with the use of some software
* competent: can use a number of software/computer applications competently
* expert: can use software and program computers competently

Table 2

Descriptive Statistics of Mean Computer Anxiety (CAS_A)*
scores for the Total Groups and Subgroups

	N	Mean**	SD
Total	40	33.13	6.03
Gender			
Male	22	36.32	3.97
Female	18	29.22	5.88
Grade***			
9	2	33.00	2.83
10	7	35.14	5.27
11	14	33.57	4.65
12	11	31.82	8.95
Beyond 12	5	32.40	5.03
Experience (Self-evaluated)			
Inexperienced	4	25.75	6.19
Novice learner	22	32.14	5.60
Competent	11	36.36	4.50
Expert	3	38.33	1.53

* Higher scores reflect lower computer anxiety

** Scores range from 10 to 40

*** Missing data resulted in rejecting one subject response set

categorical experience level. The mean CAS_A score for the females is lower than the males, suggesting higher anxiety. Of the subjects 75%, had already obtained Grade 11 and higher mathematics training. Only a minority (23%) had not completed beyond grade 10 mathematics. The means for CAS_A scores of these groups ranged between M = 31.82 and M = 35.14.

It is interesting to note the relationship between self-evaluation of computer experience and CAS_A scores. Means ascend respective to the level of experience. This suggests that lower levels of computer anxiety were associated with higher beliefs of self-evaluated experience. The greater number of subjects in the novice learner group was enough to raise the mean even though it contained the lowest CAS_A score (15). This reflects that a higher self-evaluation does not necessarily equate with consistently less computer anxiety. The idea of experience alone decreasing associated anxiety is not entirely supported.

Table 3 contains the mean scores on the CAS_C subscale. Results indicate males were higher in confidence about computers than females. Mathematics grade levels did not represent much of a range in computer confidence; the lowest computer confidence mean was found in the grade 12 group and the highest mean was represented by those who had a grade nine level of mathematics. Self-evaluated experience levels did correspond

Table 3

Descriptive Statistics of Mean Computer Confidence (CAS_C)*
scores across Gender, Grade Level, and Computer Experience

	N**	Mean***	SD
Total	38	32.82	5.23
Gender			
Male	21	35.71	3.30
Female	17	29.24	4.99
Grade****			
9	2	35.50	2.12
10	7	34.00	4.55
11	13	33.00	4.56
12	11	31.55	7.12
Beyond 12	4	33.50	4.44
Experience (Self-evaluated)			
Inexperienced	4	26.00	6.53
Novice learner	21	31.71	4.40
Competent	11	36.55	2.91
Expert	2	37.50	2.12

* Higher scores reflect higher confidence
** Two complete sets of data were rejected
*** Scores range from 10 to 40
**** Missing data resulted in rejecting one subject response set

with CAS_C means in an ascending order. Inexperienced learners had the lowest confidence, while the experts indicated the highest confidence.

Table 4 outlines the details of the CAS_L results. The CAS_L means across genders indicated that females liked computers less than males. Higher grade levels of mathematics did not indicate any pattern for computer liking. Grade level means range between M = 29.18 for those who reached a grade 12 level and M = 36.50 for those who had a grade nine level before entering the course. The CAS_L means for experience levels reflected a logical pattern with less computer liking for inexperienced subjects and more liking for experienced subjects. Although, some differences were small, there was an incremental increase across the groups.

Results from the CAS_U subscale are presented in Table 5. Of the total, males had a higher mean average belief of computer usefulness than females. Mathematics grade level groups did not show any particular pattern indicating a fluctuation in the belief of computer usefulness. Means are within a four point spread of each other in which the highest degree of usefulness was expressed by the grade 9 group. The grade 12 group had the lowest belief in computer usefulness. The group beyond grade 12, grade 11, and grade 10 group all share means by only a fraction of a score. Although small, an ascending incremental

Table 4

Descriptive Statistics of Mean Computer Liking (CAS_L)* scores across Gender, Grade Level, and Computer Experience

	N	Mean**	SD
Total	40	30.63	5.5
Gender			
Male	22	33.05	4.61
Female	18	27.67	5.11
Grade***			
9	2	36.50	2.12
10	7	31.14	5.70
11	14	30.21	3.85
12	11	29.18	7.74
Beyond 12	5	32.60	3.78
Experience (Self-evaluated)			
Inexperienced	4	24.00	3.56
Novice learner	22	29.77	5.15
Competent	11	33.91	4.39
Expert	3	33.67	5.03

* Higher scores reflect higher liking

** Scores range from 10 to 40

*** Missing data resulted in rejecting one subject response set

Table 5

Descriptive Statistics of Mean Computer Usefulness (CAS_U)* scores across Gender, Grade Level, and Computer Experience

	N**	Mean***	SD
Total	39	35.75	3.61
Gender			
Male	22	37.27	2.16
Female	17	33.88	4.24
Grade****			
9	2	38.00	2.83
10	7	36.43	2.88
11	13	36.08	3.90
12	11	34.73	3.66
Beyond 12	5	36.20	4.66
Experience (Self-evaluated)			
Inexperienced	4	33.50	5.69
Novice learner	21	35.67	4.03
Competent	11	36.64	1.80
Expert	3	36.67	2.31

* Higher scores reflect higher beliefs of usefulness

** One complete set of data was rejected due to missing responses

*** Scores range from 10 to 40

**** Missing data resulted in rejecting one subject response set

value of the group means for the inexperienced, novice learner, competent, and expert groups were present in the results.

The overall computer attitude results are shown in Table 6. Females indicated a less positive attitude towards computers relative to males. As with all of the subscales, the standard deviation for females on the CAS indicates more diversity in the composition of the group. Subjects in the grade 12 level mathematics group had the least positive attitude towards computers. A large standard deviation is evident for this group relative to the other grade levels. This is indicative of the heterogeneity in group composition. Although females are the majority in this group, explaining some of the variance, it is difficult to interpret these results because of insufficient data on relevant factors of group demographics. The other groups were higher than the sample mean, ranging between M = 133.92 and M = 143.00. There is a greater difference between the means of various experience levels. Experts had the highest mean followed, in order, by the competent, novice learner, and the inexperienced groups.

MARS results are displayed in Table 7. Females indicated higher mathematics anxiety than males. This supports findings in earlier literature indicating a gender difference in mathematics anxiety, such as reported in Tocci and Engelhard (1991). The grade 11 level mathematics group had the largest

Table 6

Descriptive Statistics of Mean Computer Attitude (CAS)* scores across Gender, Grade Level, and Computer Experience

	N**	Mean***	SD
Total	37	132.65	18.16
Gender			
Male	21	142.67	11.54
Female	16	119.50	16.99
Grade****			
9	2	143.00	0.00
10	7	136.71	16.43
11	12	133.92	14.11
12	11	127.27	24.97
Beyond 12	4	134.75	17.82
Experience (Self-evaluated)			
Inexperienced	4	109.25	17.23
Novice learner	20	129.50	16.94
Competent	11	143.64	10.53
Expert	2	150.50	7.78

* Higher scores reflect more positive computer attitudes

** Three complete sets of data were rejected due to missing subscale scores

*** Scores range from 40 to 160

**** Missing data resulted in rejecting one subject response set

Table 7

Descriptive Statistics of Mean Mathematics Anxiety Rating Scale (MARS)* scores across Gender, Grade Level, and Computer Experience

	N	Mean**	SD
Total	40	188.31	61.23
Gender			
Male	22	182.92	37.67
Female	18	194.89	53.49
Grade***			
9	2	193.50	20.51
10	7	181.71	67.59
11	14	199.57	73.18
12	11	183.29	60.94
Beyond 12	5	167.00	36.63
Experience (Self-evaluated)			
Inexperienced	4	179.75	20.93
Novice learner	22	205.55	66.80
Competent	11	149.84	35.17
Expert	3	214.33	82.71

* Higher scores reflect higher mathematics anxiety

** Scores range from 94 to 490

*** Missing data resulted in rejecting one subject response set

sample size (N= 14) and also the highest maximum score (393). Grade 9 had the next highest mean followed by grade 12 and grade 10. The group with a mathematics level beyond grade 12 had the lowest mean, which is reasonably assumed since this group had a solid foundation of mathematical skills. No pattern was evident suggesting higher mathematics levels reflected lower mathematics anxiety means. These results are dubious at best since grade level attained prior to this course was obtained without measuring the time span from the last formal course to the time of data collection. Computer experience groups did not show any pattern in mean scores on the MARS. The Novice learner and Expert groups had higher MARS means than the other groups.

Achievement (FP) mean scores of the group are shown in Table 8. Females had a higher FP mean than the males, indicating that higher anxiety did not necessarily correspond to lower achievement scores. In the mathematics grade level groups, Grade 9 and Beyond 12 had the highest means with approximately a ten point difference between the two groups; the other groups shared lower mean scores. The extreme ends of experience categories had lower average FP scores than the middle categories. Reflected in experience levels and assuming a normal distribution curve of anxiety, the FP scores imply higher achievement with moderate amounts of anxiety. The novice

Table 8

Descriptive Statistics of Mean Achievement(FP: Final Percentage)* scores across Gender, Grade Level, and Computer Experience

	N	Mean**	SD
Total	40	61.5	15.22
Gender			
Male	22	61.02	16.70
Female	18	62.42	13.63
Grade***			
9	2	68.00	15.56
10	7	54.86	18.78
11	14	59.86	11.98
12	11	59.64	15.65
Beyond 12	5	78.40	10.74
Experience (Self-evaluated)			
Inexperienced	4	50.25	10.91
Novice learner	22	64.64	15.38
Competent	11	62.46	15.69
Expert	3	52.00	11.14

* Final grade in course

** Scores range from 38 to 92

*** Missing data resulted in rejecting one subject response set

learner group and competent group are both above the mean FP for the overall sample.

Correlations

Table 9 presents the correlations among the Computer Attitude Scale (CAS), computer anxiety subscale (CAS_A), Mathematics Anxiety Rating Scale (MARS), and the achievement score (FP). The CAS and all of its subscales were significantly intercorrelated at $p < .05$. The highest correlation was between the CAS and CAS_C, $r(37) = .95$, $p < .001$. This is easily understood since a positive overall attitude towards computers more readily reflects a higher confidence than simply liking or beliefs of usefulness, which may not encompass computer interaction.

Answers to three of the four research questions may be gained from this table. The first two research questions addressed the relationships computer anxiety and mathematics anxiety may have with mathematics achievement. No statistically significant relationships were evident between the CAS_A or MARS with FP. The fourth research question addressed the effects of computer attitude on mathematics achievement; no significant correlation was found between the CAS and FP scores.

Table 10 contains the correlations between computer experience measures (computer use in hours per day and week, computer use in months/years, and computer expertise), computer

Table 9

Correlation Coefficients Between Anxiety Scores (CAS_A, MARS), Computer Attitude (CAS) and Achievement (FP)

	CAS_A	CAS	MARS	FP
CAS_A	1.00			
	(40)			
CAS	.91*	1.00		
	(37)	(37)		
	p=.000			
MARS	-.14	-.07	1.00	
	(40)	(37)	(40)	
	p=.403	p=.677		
FP	-.22	-.05	-.18	1.00
	(40)	(37)	(40)	(40)
	p=.174	p=.757	p=.255	

Number of cases shown in parentheses.

* $p < .001$

Table 10

Correlation Coefficients Between Computer Experience, Computer Anxiety (CAS_A) and Achievement (FP)

	CEC	CED	CEE	CAS_A	FP
CEC*	1.00				
	(39)				
CED*	.2833	1.00			
	(39)	(40)			
	p=.080				
CEE*	.4532	.5952**	1.00		
	(39)	(40)	(40)		
	p=.004	p=.000			
CAS_A	.5324**	.2514	.5366**	1.00	
	(39)	(40)	(40)	(40)	
	p=.000	p=.118	p=.000		
FP	-.2600	.1125	-.0076	-.2194	1.00
	(39)	(40)	(40)	(40)	(40)
	p=.110	p=.489	p=.963	p=.174	

Number of cases shown in parentheses

** $p < .001$

* CEC is "I use a computer"... hours per day and week

* CED is "I have used computers"... for months/years

* CEE is "I consider myself to be"... inexperienced/ novice learner/ competent/ expert

anxiety, and achievement. No significant relationships were found on the measure of achievement (FP). One interesting note, however, is how closely FP scores came to significance with the computer experience variable, computer access (CEB), $r(40) = .30$, $p = .06$. Computer anxiety scores showed a significant positive relationship with computer experience (CEC and CEE). This suggests that lower computer anxiety levels are related to higher levels of self-evaluated experience and more time devoted to working with computers per week. Surprisingly, the length of time in months and years did not indicate a relationship with computer anxiety. Computer ownership (CEA) showed a significant positive relationship with computer access (CEB), $r(38) = .36$, $p < .05$, and computer experience in hours per day and week (CEC), $r(37) = .36$, $p < .05$. The self-evaluations of computer experience (CEE) indicated significant positive relationships across the two temporal measures of computer experience (CEC and CED).

t-test Analyses

Table 11 displays the results of *t*-tests for significant gender differences on the CAS and its subscales, MARS, and FP scores. Of the computer experience variables only CEC had statistical significance, $t(37) = 2.77$, $p < .01$. This suggests that males spend more hours per week than females on computers. It is clear that gender differences were statistically

Table 11

t Tests of Significance Between Genders on the CAS and its subscales (CAS_A, CAS_C, CAS_L, CAS_U), the MARS, and Achievement (FP)

Variable	Mean difference	*t*-value	Degrees of freedom	2-tail significance
CAS_A	7.1	4.54	38	0.000*
CAS_C	6.48	4.80	36	0.000*
CAS_L	5.38	3.50	38	0.001*
CAS_U	3.39	3.25	37	0.002*
CAS	23.17	4.94	35	0.000*
MARS	11.97	0.61	38	0.545
FP	1.39	0.28	38	0.777

* $p < .01$

significant for the CAS and all of its subscales. Reasonably assumed, overall computer attitudes also showed statistically significant differences between genders with a large mean difference between the genders; males indicated a more positive computer attitude. No gender difference was evident for the MARS and FP means.

t-tests for high and low groups of computer anxiety, mathematics anxiety, and computer attitude were conducted on the measure of achievement (FP). Groups were based on median splits (34, 175, and 138, respectively) and showed no statistically significant mean differences. That is, no difference in mean scores across the high and low groups of either computer anxiety, mathematics anxiety, or computer attitude on any of the instruments were significant. This suggests that people with high computer anxiety, high mathematics anxiety, or a negative computer attitude were not affected such that lower FP scores reflected a disadvantage relative to their peers who had more favourable anxiety levels and attitudes.

Analyses of Variance

Since a significant difference was found between gender groups on the variable CEC, a one way Analysis of Variance was conducted to investigate an effect of this variable on CAS_A. Table 12 presents the results of the analysis. Time spent on computers per day and week (CEC) was supported as having a significant influence on variance of computer anxiety. Following, an Analysis of Co-variance was conducted to correct for the influence of CEC across genders to test whether these differences would remain; results are displayed in Table 13. A significant effect of gender on computer anxiety was still evident after correcting for CEC. This would suggest that experience did not explain the difference in computer anxiety between genders.

As expressed in the third research question, an interaction effect was investigated between computer anxiety and mathematics anxiety on achievement. Results of the 2 x 2 Analysis of Variance and cell means are displayed in Table 14. Results showed that there were no interaction effects between anxiety types (computer and mathematics) across the variable FP. This indicates that no exacerbating effect from a combination of both anxieties significantly accounted for the variance in achievement.

Table 12

One-Way Analysis of Variance of Computer Anxiety as a function of Computer Experience (CEC)

Source of variation	Sum of squares	Degrees of freedom	Mean squares	F	Significance of F
Between groups	483.15	3	161.05	6.07	0.002*
Within groups	928.6	35	26.53		
Total	1411.74	38			

* p < .01

Table 13

Analysis of Co-Variance of Computer Anxiety as a Function of Gender Correcting for Computer Use

Source of variation	Sum of Squares	Degrees of freedom	Mean square	F	Significance of F
Covariate CEC	400.17	1	400.17	18.6	0.000*
G	236.95	1	236.95	11.01	0.002*
Residual	774.63	36	21.52		
Total	1411.74	38	37.15		

* $p < .01$

Table 14

Cell Means of Achievement for High and Low Computer Anxiety and Mathematics Anxiety Groups

Total Population
61.65
(40)

Low Computer Anxiety (LC)	High Computer Anxiety (HC)
57.70	65.60
(20)	(20)

Low Mathematics Anxiety (LM)	High Mathematics Anxiety (HM)
61.43	61.88
(20)	(20)

	LM	HM
LC	59.00	55.75
	(12)	(8)
HC	65.06	65.96
	(8)	(12)

Number of cases shown in parentheses

Table 14 (cont.)

Analysis of Variance of Achievement as a Function of Computer Anxiety and Mathematics Anxiety

Source of Variation	Sum of Squares	Degrees of freedom	Mean Square	F	Significance of F
computer anxiety	624.1	1	624.1	2.69	0.11
mathematics anxiety	13.3	1	13.3	0.06	0.812
computer anxiety x mathematics anxiety	41.25	1	41.25	0.18	0.676
residual	8356.95	36	232.14		
total	9035.6	39	231.68		

Chapter 5

Discussion

The purpose of this study was to investigate the relationships between computer anxiety, mathematics anxiety, and mathematics achievement in an environment where computers were used in the design of a mathematics course. Programming skills were not required to enroll in or complete the course. The findings of this study suggest that in this environment neither computer anxiety, mathematics anxiety, nor computer attitude significantly influenced mathematics achievement.

Participants in this study were not assumed to have any skills in computer use. However, findings indicated over 50% of the subjects owned computers and only 7.5% used them for less than one hour per week. The remainder of the subjects spent considerably more time on computers. This may reflect a current trend in society for individuals to, at least, make themselves aware of technology and some of its rudimentary uses. Another explanation which may account for the insignificant results is the academic setting under investigation. Although the environment de-emphasized programming skills, it is possible people in academic surroundings are more likely to have been exposed to computers than those outside of this type of environment. One assumption was that participants would have relatively low prior mathematics experience. This was also not the case since 75% of the sample had a minimum of a grade 11 level of mathematics before entering the course. The overall high mathematical and computer foundation of participants helps explain the seeming lack of findings for relationships between the main variables. That is, high skill levels on both factors may have resulted in no supportive evidence for these relationships. If one considers the age categories it seems people are willing to take time to refresh fundamental mathematics skills in order to advance or increase their potential for progress. That is, an almost even split in age between recent high school graduate ages and those 25 and older showed signs of rekindling old skills or strengthening relatively new skills.

The composition of the sample may well have been a factor influencing relationships among the main variables under examination. Analyses did not reveal any statistically significant relationships between computer anxiety, mathematics anxiety, and achievement. This is contrary to findings such as Kernan and Howard (1990) and Gressard and Loyd (1986) who propose moderate positive relationships between the anxiety constructs. Along the lines of computer achievement Marcoulides (1988) also reported a slight positive relationship between the anxieties, however, mathematics anxiety did not significantly add to the variance in computer achievement. This helps explain why no interaction affect was found of computer anxiety and mathematics anxiety on achievement. Since mathematics anxiety does not contribute to variance in computer achievement this aspect may be reasonably rejected when considering anxiety while working in this type of a class setting; in fact, simply examining the cell means for any of the high and low mathematics anxiety groups shows negligible differences in achievement.

The sample was also divided into high and low groups of computer anxiety and computer attitude. Consistent with the results from these findings, no statistically significant differences were evident across groups on mathematics achievement. This offers support to the notion Munger and Loyd (1989) put forward that computer technology may no longer simply be assumed a proponent of mathematics and sciences. Divergence between technology and the assumed relationship with core sciences and mathematics may be growing. Computers may become, in a societal view, more of a functional tool rather than a taboo object meant for scientists and mathematicians. As software applications become more sophisticated in their functioning and easier to utilize, computer technology may continue to expand beyond mathematical and scientific applications. However, as Munger and Loyd (1989) also indicate, a small relationship may endure in the sense that calculators (computer technology) remain in a role of mathematical functioning. Specifically, a population may continue to exist which remains ignorant of computer technology such that computers are maintained as icons of mathematics or science. As the general public views computers in more diverse capacities and less associated within specific domains, their application in classrooms may increasingly benefit students. Campbell (1988) comments that students who believe computer ability and mathematics ability as unrelated tend to exhibit lower levels of computer anxiety. It is possible the lack of significance in the present findings reflect this belief as the computer becomes equally related to various other areas such as word processing, graphic design, architecture, organizing (personal organizers), and language training. However, consideration should still be given because reports in the literature indicate that mathematics anxiety acts as a predictor variable for computer anxiety (Fariña *et al.*, 1991).

Similarly, low and high computer attitude groups did not differ significantly in mathematics achievement scores. Although the sample is of a modest size, one might presume that less extreme attitudes are evidenced in society's view of computer technology. That is, what was once considered a negative, almost anti-computer, attitude may have shifted as a societal average to an attitude of tolerance or possibly acceptance. This does not imply that computer anxiety will not continue to exist, rather research may begin to investigate software applications and the tasks they facilitate as opposed to the physical apparatus which houses the programs.

The achievement scores appear to parallel the Yerkes-Dodson Law relative to computer anxiety and mathematics anxiety. The law proposes moderate levels of anxiety to reach optimal levels of performance while low and high levels of stimulation (anxiety) are detrimental to the task (Schönpflug & Schönpflug, 1983). As groups, those who evaluated themselves as novice learners and competent users received higher mean averages than the inexperienced and expert groups. At a glance (table 2 and 7), these last two groups also hold the highest and lowest scores on the CAS_A and MARS.

Relative to working in organizations and progressing through academic programs, it may prove beneficial to maintain moderate amounts of anxiety. The rationale to maintaining certain amounts of anxiety may suggest not attempting to resolve issues of computer anxiety. Although it is not a reasonable assumption to believe progress in any system is without anxiety, implementing programs reducing computer anxiety will not likely eradicate its existence. When advancement hinges on processes of evaluation other sources may begin to act as stimuli for anxiety within any domain of functioning.

A number of secondary questions were posed reflecting variables which have been studied in other research endeavours. Results from the *t*-tests revealed gender differences across an array of variables. Findings suggest no significant gender differences on achievement, which supports similar evidence presented in the findings Munger and Loyd (1989) present on gender and attitude. Generally, current research indicates females perform equally well in the mathematics courses under observation, with a slightly higher mean for females. Another variable, computer confidence, is reported as a possible factor on mathematical performance of high school students by Munger and Loyd (1989). Results from the present study did not provide evidence supporting a significant relationship between these two variables. It was more likely that subjects in this sample would own computers since relative costs have diminished since 1989. However, a significant gender difference in favour of males is observed in computer confidence. Interestingly females and males exhibited significant differences on the measures of computer anxiety, computer liking, computer usefulness, and computer attitude. Women scored significantly lower than men on all of these scales with the exception of computer anxiety, which was significantly higher for women. This suggests that although females hold more negative attitudes and have more anxiety towards computers, achievement in mathematics is not significantly influenced. Regarding prior notions of computer anxiety possibly influencing progress in a working environment or narrowing potential career opportunities, it seems computer anxiety does not bear the onus of impeding such movement. It seems females are more likely to experience negative ideas and opinions of computer technology, yet, may not be significantly influenced in achieving their goals. That is, women who choose to accept the challenge of working in an environment involving computers or take course work incorporating computers may not be at a disadvantage with respect to their male peers. Caution, however, should be extended since such generalizations extend beyond the parameters of this study. Also, persons experiencing extreme (clinical) levels of computer anxiety are not likely to enter areas involving this technology or volunteer as subjects in research related to computers. Thus, these individuals may be limited in their professional careers (Weil *et al.*, 1990).

Busch (1995) reported no statistically significant gender differences of computer attitudes after controlling for computer experience and encouragement. He took into account encouragement, which this present study did not measure. As well, the only aspect of computer experience, in the current study, which had significance was the time spent in hours per day and week using computers. Busch (1995) measured this variable by requiring subjects to indicate the extent their experience spans in word processing, spreadsheet programs, programming, or computer games. Nevertheless, the current study also corrected for the measure of computer experience; significant gender differences were found. This is indicative of the possibility that other factors accounted for the gender differences.

Todman and Monaghan (1994) contend that an early introduction to computers increases the probability of subsequent use. This may suggest that, for the sample in this study, women may have been exposed to computers later than males. It is also possible males received more encouragement and aid from their peer groups in the past while gaining experience than their female counterparts. Chen (1986) comments that young males gain more social incentives and encouragement from their peers during adolescence. Results from the current study may then reflect these ideas since females seem to spend less time on computers and maintain more negative attitudes. This might mean that women spend more time on computers for task-specific purposes while men may use them outside of obligated or necessary work. These findings may be limited due to the depth of questions related to computer experience in the demographics questionnaire. A more accurate measure may have incorporated time spent on computers during class time.

This study contradicts the notion Rosen and Maguire (1990) put forward of an exacerbating effect of computer experience on computer anxiety. The moderate positive correlations (Table 10) indicated in the results suggest lower computer anxiety levels were evidenced for those with more computer experience. Specifically, on the computer experience variable measuring hours spent on computers per day and week, more time correlated with less computer anxiety. It is possible the computer-assisted mathematics course was very well developed and any complications students may have experienced might have been diminished by the time this study was conducted. An element of time pressure was not necessarily a factor in this study since students worked at their own pace; completing assignments and writing tests were self-regulated throughout the course. Incorrect input of data may have frustrated students at the onset of the course, however, as students familiarized themselves with the software this factor may have ceased to be a source of anxiety. Unfortunately, the nature of computer experience was not determined in this study and therefore no conclusions can be drawn. It would be interesting to examine whether students' attitudes or feelings of anxiety changed over the duration of the course.

Implications

The findings of this study indicate that in an adult basic mathematics course, computer technology may be implemented into the learning environment without detrimental effects on achievement. Computer anxiety, computer attitude, and mathematics anxiety under such a setting would play nominal roles such that achievement would not be greatly hindered. Also, females, portrayed as the more "at-risk" gender of computer anxiety by media (Rosen & Maguire, 1990), who elect to enter such circumstances will not likely be at a disadvantage relative to their male counterparts. If one accepts the idea that the situation presented an opportunity to improve both computer and mathematical skills, the equal representation of both genders in the study may evidence a move towards equality in the sciences. These findings may be indicative of the accelerated movement which technology has had in the academic and consumer settings. That is, a realization of the importance and growing presence of computer technology in society may influence individuals of both genders to take advantage of such opportunities. It might also suggest society's willingness to take the initiative and learn more about current technological advancement to maintain a competitive edge or improve potential progress. In the event that some individuals might consider not going into a field of study or not contemplating an occupation in which he or she must use computers, it would be a fallacy to assume all computer technology hinders progress due to anxiety. Implications of this study are that, although there may be gender differences, factors other than computer anxiety may be more limiting to advancement in a particular occupation or work environment.

It appears the physical structure of computers in an environment is less of a profound issue in today's society. More relevant are the changes and development in using these tools most effectively. Computer anxiety levels may be moderate or low for tasks requiring fundamental skills as opposed to more advanced or new skills. As computer technology continues rapidly to change so may individual anxiety levels about the required adjustments. Also, people's willingness to learn could wane because such continual modification might be disruptive to individual lifestyles and related anxiety may increase. Researchers may be forced to redefine computer anxiety as the nature of the construct changes relative to the influence computers have in society. At an extreme end, the rate of technological change may increase to the point where society may find it ridiculous to engage new software applications and hardware.

It has also become a part of people's lifestyles to judge and be judged by their possessions. As mentioned earlier, the technological paraphernalia one has obtained may be a status marker of one's position in society. To make a glib analogy: computers may become parallel to the relationship automobiles have gained in society. A powerful computer may represent the same status symbol as a "muscle car." Likewise, obtaining sophisticated computer technology may imitate status as do economic limitations on the purchase of a Cadillac. Another analogy is possible with respect to gender differences. Stereotypes still reflect roles in occupations; males are more likely to be working as automotive mechanics than females. However, either gender is capable of managing and making these machines perform the function for which they were designed. Interests in computer technology may differ for males and females, not unlike automobiles. In general, society may find men spending time fine-tuning and "tweaking" computers, whereas, women may utilize them for more practical purposes. Thus, gender differences may continue to exist.

<u>Suggestions for Future Studies</u>

Further research on computer anxiety is warranted due to the limitations of and inconsistencies in current standards of measurement. The following are some suggestions:

1. The effects of computer anxiety need to be studied with respect to their impact on individuals' occupations or career decisions.
2. A more standardized measure of computer experience should be developed so that studies can be more readily compared.

3. The negative and positive nature of computer interaction needs to be more fully explored. This may prove beneficial to both academic and occupational settings.
4. A replication of this study might use a larger sample incorporating measures on age and duration of time since last formal training.
5. Comparing samples in academia with groups in technical, medical, and corporate occupations may prove more beneficial for generalizing to a larger population. Also, investigating differences in the hierarchical structure of occupations would advance the understanding of computer anxiety.
6. Interest for computer technology should be studied in order to gain more understanding of possible gender differences in computer anxiety.

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Appendix I

Ethics Committee Approval Form

UNIVERSITY OF REGINA

OFFICE OF ASSOCIATE VICE-PRESIDENT AND DEAN
FACULTY OF GRADUATE STUDIES AND RESEARCH

DATE: March 5, 1997

TO: Oliver Jost
Faculty of Education

FROM: G.W. Maslany, Chair
Research Ethics Review Committee

Re: **The Effects of Computer Anxiety and Mathematics Anxiety on Achievement in an Adult Mathematics Course**

Please be advised that the committee has considered this proposal and has agreed that it is:

✓ ______ 1. Acceptable as submitted.
(Note: Only those applications designated in this way have ethical approval for the research on which they are based to proceed.)

______ 2. Acceptable subject to the following changes and precautions (see attached):
Note: These changes must be resubmitted to the Committee and deemed acceptable by it prior to the initiation of the research. Once the changes are regarded as acceptable a new approval form will be sent out indicating it is acceptable as submitted.
Please address the concerns raised by the reviewer(s) by means of a supplementary memo.

______ 3. Unacceptable to the Committee as submitted. Please contact the Chair for advise on whether or how the project proposal might be revised to become acceptable (ext. 4161/5186.)

G.W. Maslany

/mm

cc: H. Miller, co-supervisor
F. Bessai, co-supervisor

(Ethics2.doc)

REGINA. SASKATCHEWAN. CANADA S4S OA2 PHONE: (306) 585-4161 FAX: (306) 585-4893
INTERNET: UGRAD@MAX.CC.UREGINA.CA

Appendix II

Computer Anxiety Research

Researcher: Oliver R. Jost

I ______________________ (please print) have been made aware that the information I provide for this project (computer anxiety study) will in no way influence my grade in this course or standing in the university. I hereby give permission to use my grade as data and I understand that my grade will not be associated with my name in any way. My identity will remain anonymous as to the information I provide. I understand that my student number is not associated with my name for the purposes of this study. Furthermore, I have been informed that not participating or withdrawing from the study will not influence my grade or standing in the university.

I understand that completing the questionnaires will take approximately 45 minutes. I have been given the opportunity to ask any questions I may have had and understand the purpose of the study. I have also been offered a written copy of the information provided prior to giving my consent.

______________________ (Date)

______________________ (Signature of participant)

______________________ (Signature of researcher)

This proposal has been approved by the University of Regina Ethics Committee.

Ethics Committee
Graduate Studies and Research
University of Regina
Phone: 585-4161

Questions may be forwarded to :

Oliver R. Jost	Dr. H. Miller	Dr. R. Bessai
187 Centennial St.	University of Regina	University of Regina
Regina, SK	585-4612	585-4565
S4S 6W3		
Phone: 585-1946		

Appendix III

Verbal Information to be Presented to Subjects

This study is set up to examine effects of computer anxiety and mathematics anxiety on achievement in this mathematics course. This research will offer new data on the shared relationship mathematics anxiety and computer anxiety may have with respect to achievement. Potential risks are minimal as the information you provide is only available to myself and the supervisory committee and is not kept/saved in a manner in which an individual's identity can be revealed. The data you provide will be stored on computer disk and all paper materials will be kept in a file box and destroyed at the completion of this project. Your student number is only required so I may match final grades with the appropriate instrument results. You will maintain the same anonymity as the university provides you through your student number. This information will not be associated with your name. The results will not be written in any publication such that individuals can be identified. Consent forms will not be attached to raw data materials in order to maintain anonymity.

For those of you who may be interested in the results of this study, you may contact myself and I will disclose the findings. The ethics committee can also be contacted for information pertaining to the study at the University of Regina, Graduate Studies and Research office in the Administration and

Humanities building. Otherwise, there will be a copy of my thesis in the library when I am done.

Participation in the study is voluntary. Withdrawal from the study at any time will not affect your grade or standing in the university. The total time to complete the questionnaires is approximately 45 minutes, each form taking approximately ten to fifteen minutes to complete. Also a typed copy of this information is available upon request.

"Are there any questions?"

Again, if you have any questions they may directed to myself or, the committee Chair may respond to questions.

(Read consent form aloud following this orally presented information)

IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6"

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