

Computer Anxiety, Training and Education: A Meta Analysis

Mayur S. Desai

Assistant Professor of Information Systems
Division of Business and Economics
Indiana University - Kokomo
P.O. Box 9003
Kokomo, Indiana 46904-9003
Office Phone: 765-455-9473
FAX: 765-455-9448
e-mail: mdesai@iukfs1.iuk.indiana.edu

Thomas C. Richards

Business Computer Information Systems Department
University of North Texas
P.O. Box 13677
Denton, Texas 76203-6677
Office Phone: 817-565-3110
FAX: 817-565-4935
e-Mail: richardt@cobaf.unt.edu

INTRODUCTION

The extensive use of computers in daily life and the overwhelming growth of information technology have created an intellectual stress and psychological pressure often called "computer anxiety." It is crucial that educators and trainers realize the adverse implications of computer anxiety on user performance. Although several researchers have studied computer anxiety, their primary focus has been on the relationship of differences such as gender, race, age, attitudes toward computers, math aptitude and math anxiety, [1,2, 3, 4, 5, 6, 7, 8, 9, 10,11, 12, 13, 14]. Although some generalizations can be drawn from previous research studies, clear relationships have not been sufficiently established between computer anxiety and performance.

This paper proposes a relationship model between computer anxiety and performance and suggests how this relationship model can be used to improve individual performance. This study defines computer anxiety as a psychological pressure on an individual due to lack of understanding of technology, its applications, and its method of operation. Performance is defined as the ability to complete manual or behavioral tasks in an effective and efficient manner using a microcomputer, keyboarding skills, a microcomputer mouse, graphical user interfaces, and other microcomputer control mechanisms.

METHODOLOGY

A three-step process was used to identify the relationship between computer anxiety and performance. Based on a review of the literature the first step was to examine the relationship

between math and test anxieties and performance. The second step in this analysis was to identify the relationship between math anxiety and computer anxiety. The first two steps were achieved by conducting a meta-analysis of existing literature. The third step was to propose a relationship between computer anxiety and performance, based on the meta-analysis, and to develop a model which demonstrates this relationship.

META-ANALYSIS

Math anxiety has been reported in a number of studies as a significant correlate of computer anxiety [1, 15, 16, 11]. In addition several researchers and educators have identified computer anxiety as comparable to math anxiety [17, 5, 18, 19]. A number of software applications, such as graphical analysis, spreadsheets, databases, and simple query scripts for data access, have a "mathematical" orientation. Software applications such as word processing may not require mathematical skills; however, interpretation of operational and control commands requires manipulation ability for successful use. An individual with computer anxiety may fear that the system will crash if the proper commands are not used in running an application and, as a result, perform computing tasks with a lack of confidence.

Step 1: Math anxiety and performance

The effect of math anxiety on the behavior and performance of individuals has been highlighted in previous studies [20, 21, 17,

22, 23, 24, 25, 26]. For example, [27] study found that the most math-anxious teachers avoid teaching math even though they may be as competent in math as their less-anxious peers. A study by [16] found that students who have low anxiety toward math and are knowledgeable about computers, were more likely to enroll in science courses. Math anxious students suffer anxiety from both math and computers. Results of a study by [25] confirmed earlier research indicating that there is an inverse relationship between math anxiety and performance. [26] who explored the relationship between test anxiety and math anxiety based on the cognitive theories of test anxiety, found that test anxiety and math anxiety are significantly correlated. [24] concluded that test anxiety has a greater effect on the math achievement of remedial math students than either math anxiety or teacher feedback. Table 1 summarizes significant research findings which indicate a relationship between math anxiety and performance.

[22]	Math anxiety directly related to students' math ability perceptions, performance expectancies, and value perceptions
[23]	Attitudes/affect toward math are important influences on the development of gender differences in math performance
[24]	Achievement in mathematics is related to mathematics ability, test anxiety, and mathematics anxiety
[25], [26]	Test anxiety inversely related to performance
[42]	the effects of goals may be non-linear
[53]	Anxiety inhibits not original learning but performance
[54], [55]	Math anxiety measures are more closely related to each other than test anxiety

It is evident from the results of the studies, noted in Table 1 that an inverse relationship exists between math anxiety and performance. It can be concluded from these studies that individuals with math anxiety tend to avoid math and tests due to some unknown fear such as poor performance.

Step 2: Math anxiety and computer anxiety

The role of computer anxiety as an intervening variable has been confirmed by a number of studies. [15, 28, 11] found that education, external locus of control, and math anxiety influence attitudes toward microcomputers indirectly through their effects on computer anxiety. [17] studied the relationships between anxiety toward computers with trait anxiety, anxiety toward mathematics, perceived impact of computers on society, and experience in using computers. All of these variables were found to be positively correlated with computer anxiety. Results of a study by [12] found that computer aptitude is related to mathematical achievement at the junior-high level. Computer aptitude refers to an individual's ability to use a variety of applications, such as databases, word processors, presentation packages, and spread sheets.

Psychologists and educators have identified the concept of computer anxiety as comparable to test anxiety and math anxiety. For example, [29] found computer anxiety to be significantly correlated with the other anxiety indices, state anxiety, trait anxiety,

and math anxiety. In another study, [18] found that computer aptitude is related to math ability and experience, whereas attitude toward computers is related to math anxiety and computer experience. A moderating relationship between the math anxiety and computer anxiety was discovered by [30]. [19], who examined the definition, measurements, and correlates of computer anxiety, also found that computer anxiety is similar in nature to math anxiety and test anxiety. On the other hand, [31, 32, 30] found a moderate relationship between math anxiety and computer anxiety. It can generally be concluded from the results of the majority of these studies that a positive correlation exists between math anxiety and computer anxiety. Table 2 summarizes the results of previous studies on the relationship between math anxiety and computer anxiety.

[16]	Students with low anxiety toward mathematics and computers prefer science courses
[15], [11]	Mathematics anxiety and Math anxiety are similar
[17], [18]	Computer anxiety and Math anxiety are similar
[30]	A moderate relationship was found between math and computer anxiety
[32], [19]	Relationship between math and computer anxiety is not strong Computer anxiety is similar in nature to math/test anxiety

Step 3: Computer anxiety and performance

The review of a number of studies indicates conflicting results regarding the relationship between computer anxiety and performance. For example, [33, 20] found that performance on examinations was not unduly affected by computer administration of the tests. [34] found that extroverts and subjects with low computer anxiety obtained significantly lower scores on a computer version of the GRE than did their counterparts.

[35] who investigated the effects of a computerized test incorporating traditional test formats on student performance, anxiety level, or attitude toward the computer, found no difference in student performance but a significant difference in anxiety level among students. [36] conducted two experiments to determine whether scores on computerized tests would significantly differ from scores of tests using a paper-and-pencil format. Their results showed reduced performance on computerized tests. However, the student's reduced performance was not related to computer anxiety or computer familiarity.

[37] who examined factors related to computer anxiety as measured by the Computer Anxiety Index (CAIN), found that performance was inversely related to computer anxiety. They further discovered that students with more computer experience had lower computer anxiety than did students with less experience. The results of both studies indicate that students with a more positive attitude toward computers and calculators perform better than do students with more negative attitudes [38]. Feelings

of anxiety toward computers were also found to negatively influence students' computer use [39] and subsequent performance. [39] further found that computer self-efficacy (judgment of one's ability to use a computer) provides additional insight into an individual's willingness to use computers.

[40] demonstrated the use of command lines and a graphical interface in a communication research course in order to compare the anxiety level of users. The subjects in Caplan's study ran a computer program using either command lines or a graphical interface. Pre-tests and post-tests measured the participants' computer anxiety. Results indicated that the interface type did not have an effect on subjects' level of computer anxiety for novice users.

These results show that the relationship between computer anxiety and performance is unclear. Reduced performance can be attributed to factors other than computer anxiety. For example, an individual taking a test using a computer may have more anxiety due to the test rather than using the computer. The cause of reduced performance in such a case is not apparent. However, using the results of steps 1 and 2, a relationship between computer anxiety and performance can be hypothesized. Table 3 summarizes the research findings regarding the relationship between computer anxiety and performance.

Table 3: Summary of Findings - Relationship between Computer Anxiety and Performance

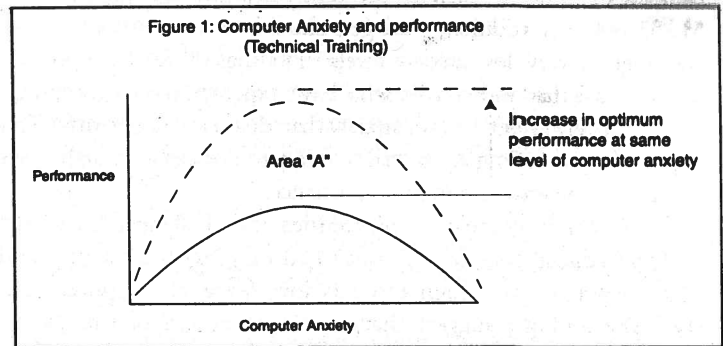
[36]	Reduced performance is not related to computer anxiety or computer familiarity
[56]	Teaching anxiety management skills may be most appropriate when software is relatively difficult to use
[57]	Computer anxiety is a valid construct and it can affect performance by serving as a stressor and possibility it can be lowered in certain training situations
[45]	Expanded instructional format does not significantly affect computer anxiety/performance
[58], [37]	Computer anxiety and performance are inversely related
[46]	Familiarity with keyboarding skills increases awareness and understanding about computers and decrease anxiety
[35]	Computerized tests produced no differences in performance but a significant differences in anxiety levels
[5]	No significant relation between computer anxiety, performance, or the use of microcomputer
[1]	Computer Anxiety does not affect the ability of individuals to use computers
[29]	An unwillingness to learn about computers is not related to negative attitudes or beliefs about computers
[59]	How long computer anxiety persists is a function of the work environment and the training received, rather than a lack of desire
[3]	Gender, age, and job title are related significantly to computer anxiety
[2], [60]	gender is highly correlated with computer anxiety. Computer training decreased computer anxiety and had an indirect effect on attitude toward microcomputers

Proposed relationship model between computer anxiety and performance

Because math anxiety and performance are negatively related and math anxiety and computer anxiety are positively related, it is reasonable to posit that a negative relationship exists between computer anxiety and performance. However, studies of computer anxiety and performance indicate contradictory results. Thus, there is reasonable doubt concerning a definitive relationship between the computer anxiety and performance. Also, in all the studies, the effects of anxiety were assumed to be linear. However, the effect of test anxiety may depend on the amount of

anxiety experienced [22]. Moderate levels of math anxiety may facilitate achievement striving, whereas extremely high levels of anxiety levels may disrupt performance.

It is reasonable to deduce, based on these studies, that computer anxiety and performance are related in a shape of an inverted cup (see Figure 1). Very low levels and very high levels of computer anxiety produce low levels of performance, whereas moderate levels of computer anxiety appear to provide the best performance.



DISCUSSION AND RECOMMENDATIONS

Inverted cup relationships are not uncommon and have been suggested in goal setting theory and achievement motivation research, [14, 42, 43]. The relationship between computer anxiety and performance is similar to the relationship previously proposed by [44]. These relationships are not unlike those found during Locke's research on goal setting [44]. [44] found that very difficult and very easy goals produce lower levels of performance than do moderate goals; that is, moderate goals produce the best performance.

Causes and Remedies for reducing computer anxiety

[45] concluded that although prior computer use does not affect computer anxiety or performance, training instruction is effective in reducing computer anxiety. [46], who investigated the relationship between keyboarding skills and computer anxiety, found that keyboarding is a basic skill related to the efficient use of computers. Familiarity with the keyboard stimulates the interests and enables an individual to improve his or her awareness and understanding of computers. Thus, familiarity results in reduced anxiety and a potential for improved performance. [1] study results do not support the contention that women generally exhibit higher levels of computer anxiety than do men. [1] also found that perceived knowledge rather than experience is a predictor of computer anxiety.

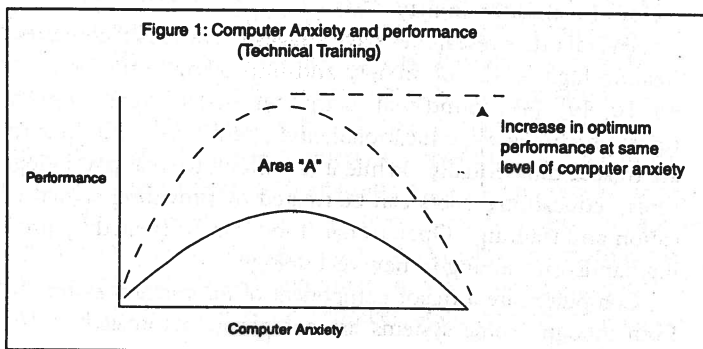
Several other researches have suggested various techniques for treating high levels of anxiety and improving performance [14, 48, 10, 49]. [49] found that computer anxiety stems from three roots: psychological, educational, and operational. All three roots are treated differentially. While it is difficult to treat psychological roots, educational roots can be treated by providing related education and training. Operational roots can be treated by providing hands-on training in new technology.

Computers are a major component of information systems (IS). Even though some systems are completely automated, there are

applications of computers in IS where human interaction is inevitable (e.g., banking, manufacturing, reservation and inventory systems). In operating these systems, human intervention is critical to monitoring proper operation of the computer programs. Individuals with high levels of computer anxiety using these applications may not perform at the optimum level. In such cases it is important to take remedial action to reduce their computer anxiety. If a moderate level of anxiety produces highest levels of performance, then an attempt should be made to induce an increased level of anxiety in employees [47, 50, 51, 52, 48]. In addition, managers should be careful not to create very high or very low anxiety levels. Findings of this meta analysis also indicate that individuals who have experience with computers show relatively lower level of anxiety than do their counterparts. This implies that providing additional training to novices with high levels of anxiety may enhance their performance.

These findings create opportunities and challenges for industrial and educational institutions to create jobs, assignments, and tasks, that avoid very high and very low levels of computer anxiety. The authors suggest that an empirical test of this model should include the measure of task complexity, individuals' ability and experience, education level, and general anxiety level. One issue that needs examination is the two types of anxiety: state anxiety, which is caused by the situation at hand and trait anxiety, which is defined as the disposition to react with worry, tension, and fear of failure in an evaluative situation [7, 8].

Performance could be improved in two ways: technical training and psychological training. For example, state anxiety could probably be treated using various techniques such as extensive training based on an explanation of the reason for using a computer and how it can help alleviate tedious elements of the task (see Figure 1, Area A). However, trait anxiety requires special attention because it is more than a situational phenomenon. Further research is needed to determine the interaction of trait anxiety and computer-related performance. In order to sustain the performance of an individual at an acceptable level for a longer period (see Figure 2, Area B), an individual could be given behavioral and rigorous technical training in various computer applications. There appears to be two separate areas of research in treating computer-related anxiety and its effect on an individual's performance. One is the behavioral training; the other is technical training. Behavioral training research will provide a better understanding of how to maintain an individual's performance level at higher levels of anxiety. Technical training research will help managers in the design of training programs that will enhance an individual's performance at a certain level of anxiety.



CONCLUSION

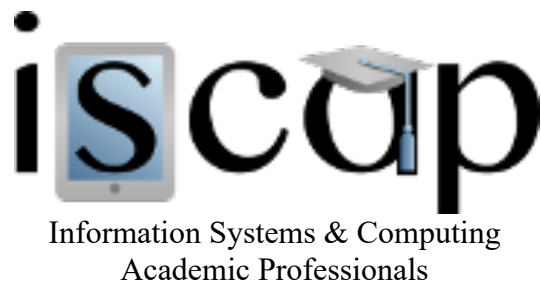
Industry and academia are working jointly in defining the curriculum for students so that students are prepared for the new technology when they join the work force. In addition managers require that their employees keep up with technological change by upgrading their skills through internal and external training programs. This paper serves as a guide for these trainers and educators who provide adequate training for those individuals who have high levels of computer anxiety. A key to the successful transition to a new computer environment is to identify factors that invoke anxiety and reduce their effects. One viable solution is to provide both behavioral training and technical training to those individuals who are better performers but have a high level of anxiety. A study by [51] suggests that in business environments, adult workers should be trained to become proficient in the areas of word processing, communications, and data unloads. The way to achieve this is to provide formal classroom training, training literature and computer-based training. If new hardware and software create special anxieties, the companies should provide customized training where the instructors draw on real tasks as examples [50]. In conclusion, for better productivity and profitable business, organizations should not overlook any indications of anxiety among employees during transition to and implementing of a new information technology.

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