The Effect of Anxiety on Performance In Learner and Programme Controlled Computer Assisted Instruction.

GILLES PRESCOTT

Submitted in Partial Fulfillment
of the
Requirements for the Degree
of Master of Arts in Educational Psychology
Department of Educational Psychology and Sociology

McGILL UNIVERSITY

1978

The Effect of Anxiety on Performance in CAI

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

Acknowledgements

Many people have given their time, their effort and their thoughts. I would like to thank Pierre Parent and Charles Quesnel who made the CAI course possible by their assistance in the programming and debugging of the lessons. Also, Professor Socrates Rapagna, who made his statistics class available for the study, was very generous in offering his time and help. I would like to thank Dr. Bruce Shore and Dr. Phil Abrami for their comments on the manuscript. Finally, thank-you to my supervisor, Patricia Cranton, who unselfishly gave of her time and efforts. By her comments, help and support, this work was made possible.

ABSTRACT

This study investigated the effect of anxiety on performance in learner and programme controlled computer-assisted instruction (CAI). It was anticipated that the difference in programming structure associated with a certain anxiety state or anxiety trait level would influence the performance of students in a CAI situation. It was hypothesized that high state anxiety students would perform better in learner controlled than in programme controlled computer-assisted instruction. It was also hypothesized that trait anxiety would not be related to performance and state anxiety would vary depending on the programming structure. Twenty-one students in a statistics class were tested on their trait anxiety and then separated into high and low groups, half of each group being assigned to programme control and the other half to learner control. They took one and a half weeks to complete the course during which the performance and state anxiety level were recorded. The results showed that trait anxiety was not related to performance but that, in accord with the hypotheses, the students with high state anxiety performed better in the programme controlled situation. The two major hypotheses were accepted; however, hypotheses about state anxiety level in the two situations were not supported by this research. Finally, practical applications and implications for further research were discussed.

RESUME

Cette étude avait pour but de scruter l'effet de l'anxieté sur la performance,dans une situation d'apprentissage contrôlée soit par la programmation, soit par l'étudiant, dans un cours donné par ordinateur. Nous pensions que la différence dans la structure de programmation associée à un certain état d'anxieté ou trait d'anxieté aurait une influence sur la performance des étudiants. Notre première hypothèse supposait que parmi les sujets ayant un état d'anxieté élevé, la performance serait plus élevée pour les étudiants qui ont le contrôle de l'apprentissage comparativement à ceux ou l'apprentissage est controlé par la programmation de l'ordinateur. Une autre hypothèse voulait que le trait d'anxieté ne soit pas relié à la performance et que l'état d'anxieté varierait selon les situations de programmation. Vingt et un étudiants d'un cours de statistique ont été testé sur leur niveau de trait d'anxieté et ensuite furent séparés en deux groupes(trait d'anxieté élevé et bas); une moitié de chacun de ces groupes fut assignée à une situation d'apprentissage controlée par la programmation et l'autre moitié à une situation d'apprentissage controlée par l'étudiant lui-même. On leur alloua une semaine et demie pour compléter le cours durant lequel la performance et l'état d'anxieté furent enregistré. Les résultats démontrèrent que le trait d'anxieté n'était pas relié à la performance et que tel que prévu les étudiants ayant un état d'anxieté élevé obtinrent une meilleur performance dans la situation ou l'apprentissage est contrôlé par l'étudiant. Les deux hypothèses majeures furent acceptées; par contre les hypothèses concernant le niveau d'état d'anxieté dans les deux situations d'apprentissage furent rejetées. Enfin,les implications soulevées pour les applications pratiques et pour la recherche future furent discutées.

CHAPTER ONE

REVIEW OF THE LITERATURE

Introduction

In recent years researchers have investigated the effect of anxiety on performance and the effect of programme structure on performance. However no research, to this date, has looked at the joint effect of programme structure and anxiety on performance. The purpose of this research is, therefore, to investigate the effect of two computer-assisted instruction (CAI) programmes on trait and state anxiety and on student performance. The drive theory of anxiety and the trait-state anxiety theory will provide a conceptual framework within which research on anxiety and computer-assisted learning will be examined.

The two programme structures investigated are learner controlled and programme controlled CAI. If the research can show a difference in performance between these two programmes based on anxiety level, it will provide a tool for assigning students to either strategy and therefore improve their learning and performance.

Drive Theory

To examine the effects of anxiety on learning, a theory of learning that specifies the complex relationship between anxiety and performance is needed. Formulated by Spence (1958) and Taylor (1956), drive theory attempts to integrate associative and motivational variables in learning.

A detailed statement of the current status and empirical evidence supporting this theory was published by Spence and Spence in 1966. The drive theory is based on Hull's (1943) concept of drive (D) which states that "an excitatory potential E which determines the strength of a given response R is a multiplicative function of total effective drive state D and habit strength H, giving the formula: $R = F(E) = F(D \times H)$" (Taylor, 1956, p. 303). The effect of variations in D on performance predicted by Hullian theory is stated by Taylor:

> The implication of varying drive level in any situation in which a single habit is evoked, is clear: The higher the drive, the greater the value of E and hence of response strength. Thus in simple noncompetitional experimental arrangements involving only a single habit tendency, the performance level of high-drive S's (subjects) should be greater than for low drive groups. Higher drive levels should not, however, always lead to superior performance (i.e., greater probability of the appearance of the correct answer). In situations in which a number of competing response tendencies are evoked, only one of which is correct, the relative performance of high and low drive groups will depend upon the number and comparative strength of the various response tendencies (Taylor, 1956, p. 304).

The drive theory's three major assumptions concerning the learning process are: (a) Both correct and incorrect response tendencies are evoked by a learning task, and the latter continue to be elicited even if the correct response is learned; (b) both correct responses and competing error tendencies are multiplied by D; and (c) performance is jointly determined by level of D and the relative strengths of correct and competing response tendencies.

Concerning the effect of anxiety (D) on learning, drive theory predicts that the performance of high-anxious subjects will be inferior to that of low-anxious subjects on a complex or difficult learning task in which competing error tendencies are stronger than correct responses. In contrast, on simple learning tasks, in which correct responses are dominant relative to incorrect response tendencies, it would be expected that the performance of high-anxious subjects would be superior to that of low-anxious subjects. This latter statement will be the basis of one of the major hypotheses of this research.

Drive level is measured by the Taylor (1953) Manifest Anxiety Scale (MAS). It is generally believed that individual differences in Taylor MAS scores reflect differences in D. The construct validity of the MAS was demonstrated by Spence (1964).

The findings of most studies utilizing the MAS as a measure of D have supported the drive theory (Lucas, 1952; Montague, 1953; Raymond, 1953; Spence, 1964; Spence & Spence, 1966; Taylor & Chapman, 1955).

Trait-State Anxiety Theory

Based on research findings, Spielberger suggested that an adequate theory of anxiety should distinguish conceptually and operationally between anxiety as a transitory state and as a relatively stable personality trait. This situation evolved from the ambiguity of research on anxiety and learning guided by the drive theory. According to Spielberger:

> Anxiety state (A-State) is characterized by subjective conciously perceived feelings of apprehension and tension accompanied by or associated with activation or arousal of the autonomic nervous system. Anxiety as a personality trait (A-trait) would seem to imply a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively nondangerous circumstances as threatening, and to respond to these with A-State reactions disproportionate in intensity to the magnitude of the objective danger (Spielberger, 1966, pp. 16-17).

A major task for the trait-state theory of anxiety is to specify the characteristics of stress inducing stimuli that evoke different levels of A-State in subjects who differ in A-Trait. On the basis of a review of the research findings obtained with various anxiety scales, Saranson (1960) noted that the performance of subjects with high scores on various measures of anxiety was more adversely affected by failure than was the performance of subjects who scored low on these measures. Denny (1966) and Spielberger and Smith (1966) obtained the same result on learning tasks with ego-involving instructions which evoked a higher level of A-State intensity in high A-Trait subjects than in low A-Trait subjects. Whether or not a particular high A-Trait individual will show an elevation in A-State in a specific situation will greatly depend upon the extent to which the subjects perceive or appraise the situation as threatening and will also be influenced by his past experience.

Therefore, when a stimulus situation is appraised as threatening, trait-state anxiety theory posits that: (a) An A-State reaction will be evoked; (b) the intensity of the A-State reaction will be proportional to the amount of threat the situation poses for the individual; and (c) the duration of the reaction will depend upon the persistence of the stimuli and the person's previous experience in dealing with similar circumstances. The theory also identifies two classes of stress inducing situations: (a) Circumstances in which personal adequacy is evaluated appear to be more threatening to high A-Trait subjects than to low A-Trait subjects; and (b) situations that are characterized by physical danger are not interpreted as any more threatening by high A-Trait individuals than by those with low A-Trait.

Speilberger, Lushene and McAdoo (1969) suggest that the results of research on anxiety and learning are consistent with the hypothesis that A-Trait subjects respond with higher levels of A-State than low A-Trait subjects in situations that are made stressful by failure or ego-involving instruction. It follows from drive theory that high D associated with a higher level of A-State facilitates performance on simple tasks in which correct responses are dominant and leads to performance decrements through the activation of erroneous responses on difficult tasks in which there are strong error tendencies.

For a long time, research on anxiety and learning has used the MAS as a measure of anxiety to select subjects on the assumption that those with high scores were higher in D than those with low scores. Since the MAS appears to be a measure of trait anxiety (Spielberger, 1966) this procedure is questionable.

The concept of D is logically more closely associatied with A-State than with A-Trait. Since drive theory specifies the effect of individual differences in D on performance in learning experiments, it seems more reasonable to infer differences in D from measures of A-State than by selecting subjects who differ in A-Trait.

All in all, the classes of variables that Spielberger (1969) believes to be most significant in anxiety research are: (a) the characteristics of stimuli both external and internal, that evoke A-State; (b) the nature of the cognitive processes that are involved in appraising various stimuli as dangerous or threatening; and (c) the defence mechanisms that are employed to avoid A-State or to reduce the intensity of this state once it is experienced.

The State-Trait Anxiety Inventory (Spielberger, 1968) consists of two scales: an A-State scale containing 20 items that ask respondents to indicate how they feel at a particular moment in time, and an A-Trait scale also containing 20 items requiring respondents to indicate how they generally feel. Discussion of the reliability and validity of this inventory is given in the STAI manual (Spielberger, Gorsuch & Luschene, 1970). Correlations between A-State and A-Trait range from .11 to .67. Test-retest reliability was demonstrated by a Pearson correlation of .83. A correlation of .39 was found between A-Trait and pretest A-State and a correlation of .32 between A-Trait and postest A-State. Both correlations were significant at the .01 level of confidence.

Computer-Assisted Instruction

Computer-assisted instruction provides a convenient natural setting in which it is possible to evaluate the learning process under carefully controlled conditions with materials that are relevant to the real-life needs of the subject. Many studies concerning the effects of anxiety on learning have involved CAI settings. Computer-assisted instruction has been defined as a situation in which a computer is used to control the selection and evaluation of instructional material (Fishman, Keller & Atkinson, 1968). In a CAI system, the computer has an instructional role and interacts with the students. CAI can be viewed as an individualization technique in education. Computer power is potentially great enough to go beyond programmed instruction and to individualize at many levels simultaneously. Decisions on instructional management can be left to the student, either in part or in entirety. The students can therefore have different degrees of responsibility or control over the instructional process. This leads to two types of programming: learner controlled and programme controlled instructional sequences.

In the learner controlled situation, the students may have control over the order of presentation of the course, the use of tests, the use of examples, formulae, and so on, depending on the structure of each particular programme. In the programme controlled situation, the student is restricted by the instructional decisions made by the computer programme, and does not have any control over the learning materials. It is then suggested that the learner controlled situation would be an easier task in an instructional situation because there are more tools available to the students to increase the probability that they answer the questions correctly. Since the learner control students can use the computer to provide test examples and formulae when required there is a greater chance that performance levels will be higher. A more thorough explanation of learner controlled and programme controlled structures will be given before going to the review of the literature on anxiety and CAI.

Learner Controlled and Programme Controlled Computer-Assisted Instruction

As mentioned previously, two of the many strategies to present course material in CAI are learner controlled and programme controlled. The general structure of these strategies will be presented, using the description of the Ontario Institute for Studies in Education (OISE) 1974-1975 project as an example. In reality, there are many variations in the definition and use of learner controlled and programme controlled CAI.

Programme Controlled CAI

In programme controlled CAI, students take instruction on pre-determined topics in a prescribed sequence. In one OISE programmes, students begin with an example problem from the first objective (see Figure 1, flowchart). Along with the example problem and the answer, any new symbols or formulae are explained. If the objective is the first in a topic, there is an introduction to the topic. Then the student may choose to proceed to a test; if not, he may then see either the sample solution or the first level of instruction. If the student wants to refresh his memory (later during the course), he might choose the sample solution; the student may ask for the first level of instruction if he feels he is not yet ready for a test, or he knows nothing about the topic.

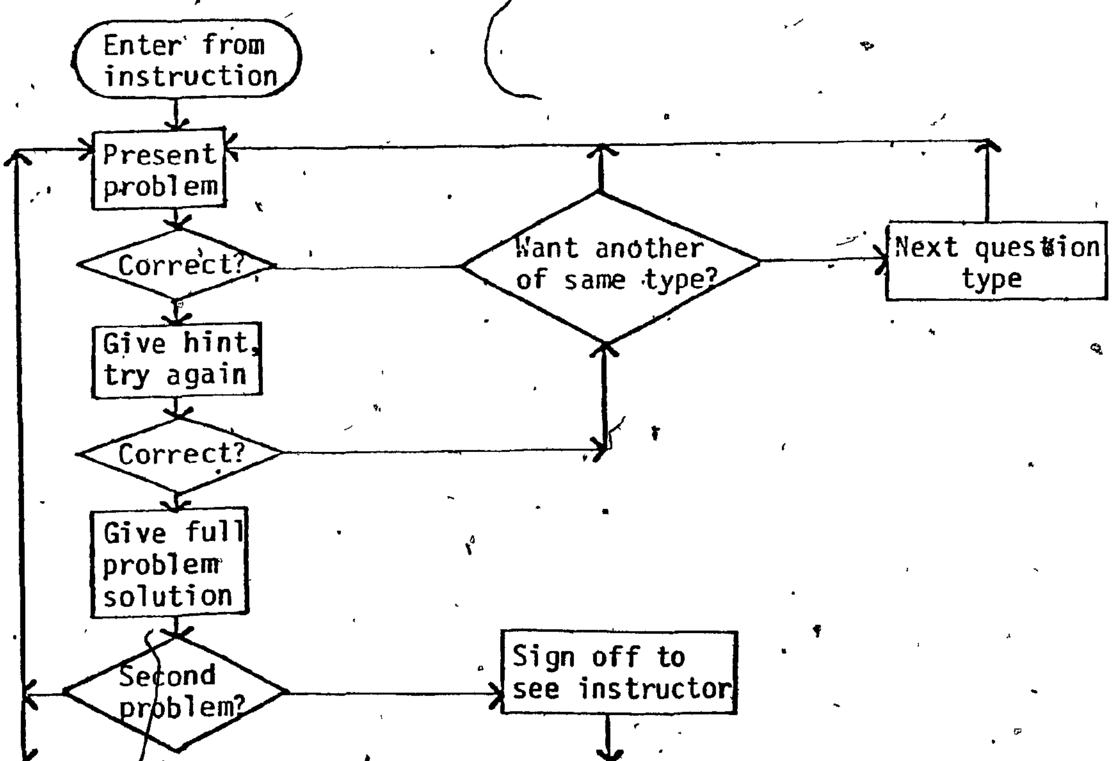

Figure 1. Flowchart OISE Programmes.

After the first unit of instruction, the student may choose between a test or a second level of instruction. When the student reaches the last level of instruction, he is given the test automatically. The student always has the choice of taking a test at any level. When the test for an objective has been passed, the student moves to the next objective. If, however, he fails the test at any level, he is required to take the following level of instruction, if any. For example, if the student fails after seeing only the introduction or the sample solution plus instruction he is then given the first level instruction, or if he fails at the first level instruction he is required to take the second level instruction, and so on. However, if he fails after having taken all the available instruction, he is asked to refer to his instructor for assistance.

While the student is progressing through the topic, he may interrupt the programme and make use of a limited set of control words, those words being also available to the student in the learner controlled situation. (See the first four words listed below in the learner control section as an example.) After the student has used a control word, he is returned to the course at the point he interrupted it.

Learner Controlled CAI

The students under this condition are not controlled by the programme according to the flowchart. They determine their own progress through the course by using a set of control words. In the OISE project a control word is used in response to the computer message "Enter your control word" and this message is obtained by typing two specific characters whenever the terminal stops printing and waits for the input. Control words used by both the learner control and programmed control groups include:

- CW : List available control words and their description,
- COM : Allows student to enter comment,
- FOR : List formulae used in the course,
- GLO : Allows access to the glossary of terms.

Control words available only to the learner control student are:

- LES : Introductory lesson to the terminal,
- EX,n : which prints n examples for each objective in topic X,
- Ex,y,n : which prints n examples for topic X, objective Y,
- Px,n : which prints n practice questions for each objective in topic X.

Note here that we are presenting only four control words of each group as an example; in reality there are several other words available.

In a learner controlled situation students require a knowledge of the course structure, strategy and content in order to use the control words meaningfully. Therefore, students in this type of programme should be provided with some background material or encouraged to acquire some familiarity with the use of the control words and the course structure.

Definitions of learner control vary considerably in the research, ranging from allowing the student control over instructional sequence, to completely interactive approaches, providing the student with control over the content, format and structure of the instruction.

Anxiety and Performance in CAI Learning

Research on CAI and anxiety began at Florida State University where studies were designed to test hypotheses derived from trait-state anxiety theory and drive theory. O'Neil, Spielberger and Hansen (1969) investigated the relation between A-State and performance for 29 college students who learned mathematical material. An IBM 1440 (IBM, 1967) system presented the learning material and recorded responses. Anxiety was measured by the A-State scale of the State-Trait Anxiety Inventory (STAI) and changes in systolic blood pressure. Both A-State scores and blood pressure increased when students responded to difficult learning material and decreased when subjects responded to easy material. Moreover, students with high A-State scores made more errors on difficult material and fewer errors on easy material than subjects with low A-State.

These findings were extended by O'Neil, Hansen and Spielberger (1969) who investigated the impact of task order to A-State and computer-assisted learning. The subjects were college males with extreme scores on the STAI A-Trait scale. Easy and difficult tasks were presented by an IBM 1500 system (IBM, 1967); responses and latencies were recorded. The computer also presented the STAI A-State scale before, during and after the learning task. The subjects were separated into two groups: the first one receiving the easy material followed by the difficult material, and the second group receiving the difficult material followed by the easy material. It was found that high A-Trait subjects responded with a higher level of A-State during the learning task than low A-Trait subjects.

O'Neil (1969) investigated the effect of two levels of stress on A-State intensity and performance for college females who differed in A-Trait. The learning material consisted of mathematical concepts presented by an IBM 1500 (IBM, 1967). Different levels of psychological stress were induced by feedback concerning the performance. In the stress condition subjects received negative feedback while a rest period took place in the non-stress condition. The two measures of performance were errors and response latencies. The results showed that high A-Trait subjects in the stress condition showed a significantly greater increase in A-State from pretask levels than did the low A-Trait subjects. During the learning task, high A-Trait subjects in the stress condition showed a marked decline in A-State, whereas level of A-State remained constant for low A-Trait subjects. In the non-stress condition, the change in anxiety state was quite similar for both high and low A-Trait. There was no relationship found between A-Trait and errors on the learning task. In contrast, subjects with high levels of A-State made more errors than low A-State subjects throughout the learning task. Finally, the difference in performance of high and low A-State subjects was significant for the easy section but not for the difficult section of the learning task.

The relationship between A-State and errors differs from that found in the 1969 O'Neil et al. research. A possible explanation could be in the difference of anxiety effect for males and females.

Leherissey, O'Neil, Heinrich and Hansen (1973) investigated the effect of familiarity and programme length on achievement in a CAI task. Here again, high A-Trait was associated with high A-State; however, shortening the programme length did not reduce state anxiety, although in some cases, it improved performance.

The effect of memory support on state anxiety and performance in CAI was also investigated by Leherissey, O'Neil and Hansen (1971). The subjects were 60 male undergraduates randomly assigned to memory support (MS) and non-memory support (NMS) conditions. The learning material consisted of a mathematics programme on complex numbers. Receiving the same learning material, the MS group was allowed to see their previous incorrect responses to each problem before attempting it again; in NMS, this information was not provided. They found that in MS, subjects with high A-State made fewer errors than in NMS and low A-State subjects performed equally well with or without NMS. A-Trait was not related to performance; these results were consistent with previous studies.

Tobias and Duchastel (1973) investigated the effect of behavioral objectives, sequence and anxiety in CAI. One hundred seventeen college students received, through an IBM 1500 system (IBM, 1967), either instructional objectives or no objectives for a logical or random instructional sequence. Performance measures and trait-state anxiety scores were obtained. Results indicated that objectives had no effect whereas the logical sequence reduced programme errors and increased achievement. No significant differences between groups or interactions among objectives, sequence and anxiety were found.

Some studies also investigated race, IQ, task structure, stress, etc., as factors relating to anxiety in a CAI situation (Bachor, 1973a; Bachor, 1973b; O'Neil, 1972; Hawkes & Furst, 1971). No consistent trends were found in these studies.

The sequencing studies then led to the learner control approach to instruction. Two of the assumptions on which learner controlled computer-assisted instruction have been based are: (a) instruction administered under learner control will be less threatening than if administered under programme control, and (b) the student is sufficiently aware of his learning state to make, in most instances, his own instructional decisions. Many studies investigated the added effect of learner controlled CAI on anxiety and performance level.

Collier, Poynor, O'Neil and Judd (1973) compared a learner control treatment group to two programme control groups. The comparison of the performance of the groups showed that the treatment (learner control) was indeed facilitating performance. Moreover, learner control subjects demonstrated a significantly lower mean state anxiety level than did either of the control groups.

A replication of this experiment was done by Judd, Daubek and O'Neil (1975) without success. Learner control over a facilitating treatment did not reduce state anxiety. The authors note that the failure to replicate the results reported by Collier et al. (1973) could be attributed to the difference in learning material; Collier's task involved concept identification as opposed to the paired associate nature of Judd's task which appeared to be much more difficult. This research is described in Judd's (1972) extensive review of the literature on learner controlled computer-assisted instruction.

Gallagher (1970) investigated instructional treatments and learner characteristics in a computer managed course and found that the students who were most successful also liked to be active in the learning situation, had few feelings of anxiety, and expressed a positive attitude toward CAI. A relationship was found between on-task anxiety state and performance on quizzes.

Hansen (1972) found that reduction in A-State can be obtained through increased use of feedback. While feedback generally seems to reduce A-State, high A-State appears to interfere with the learner's capacity to utilize the feedback information effectively in performing the task requirements. He noted that learner control seems to offer definite advantages both in terms of anxiety reduction and performance.

Again in 1974, Hansen investigated the effects of feedback, learner control, and cognitive abilities on state anxiety and performance in a CAI task. Hansen administered a battery of ability tests measuring general reasoning, associative memory and trait anxiety to 98 female undergraduates. The subjects were randomly assigned to three groups(no-feedback,feedback and learner controlled feedback) for a CAI course on the Xenograde system.

State anxiety measures were taken prior to the course, following the administration of stress instruction, at the midpoint of the course, and at the end of the course. Learner controlled feedback subjects decreased more in A-State than did feedback subjects. High A-State subjects made more errors under feedback than under no feedback. Feedback facilitated performance for high-reasoning subjects but impaired performance for low reasoning subjects.

Judd et al. (1974) did not find a reduction of anxiety state when subjects used a learner controlled programme in a CAI task. Moreover, the use of mnemonics in the learner controlled programme did not provide a facilitating effect. These controversial findings are analyzed by Steinberg (1977). She notes that: "Because the data base is inadequate and the experimental results are highly variant, it is not possible to make generalizations regarding the locus of control in CAI" (p. 88). Throughout these experiments four sources of confusion became apparent: (a) A lack of concensus as to the definition of "learner control"; (b) a lack of attention to individual differences in the use of learner control; (c) the absence of evidence that the instructional variables placed under learner control have an appreciable effect on learning; and (d) a lack of specificity in measures of the presumed affective advantages of learner control.

We can, however, summarize by saying that learner control apparently has facilitating effects on learning and leads to reduction of state anxiety. Based on the findings reported in this section and the theories reported in the two previous sections hypotheses for the current study will be presented.

Research Hypotheses

The purpose of this study is to investigate the effect of two learning situations, learner control and programme control, on anxiety and performance in a CAI setting. The following predictions were made for the two CAI situations.

Hypothesis 1: The Learner Controlled Situation

a) Trait anxiety will not predict state anxiety in the learner controlled situation.

b) Subjects in the learner controlled situation will have an anxiety state level lower than subjects in the programme controlled situation.

c) Trait anxiety will not predict performance in the learner controlled situation.

d) State anxiety will predict performance in the learner controlled situation; high state anxiety will result in higher performance.

Hypothesis 2: The Programme Controlled Situation

a) Trait anxiety will predict state anxiety in the programme controlled situation; high trait anxiety will result in higher state anxiety scores than low trait anxiety.

b) Subjects will have a higher level of state anxiety than subjects in learner control.

c) Trait anxiety will not predict performance in the programme controlled situation.

d) State anxiety will predict performance in the programme controlled situation; high state anxiety will result in lower performance than in learner control.

Two types of statistical analyses will be used to test these hypotheses, based on the data obtained at the end of the experiment. First, a t-test will be used to test the hypotheses predicting lower state anxiety level for learner control than for programme control (1b and 2b). Since the extreme anxiety levels which yield a curvilinear relationship with performance were not included in this research, the remaining hypotheses will be analyzed using a linear regression model which permits an examination of the interactions and also increases the power of the test over an analysis of variance. More details on the analysis are given in the results section.

CHAPTER TWO

RESEARCH DESIGN

Subjects

The subjects were 21 students enrolled in a graduate level course, "The Uses of Statistics in Educational Procedures" (414-602D) at McGill University during the fall and winter session of 1978-79. There were 11 women and 10 men with a mean age of approximately 24 years of age. The experiment was built into the curriculum so that it would be as much as possible, a "real life situation". The selection of the subjects was based on registration for this course.

The Anxiety Measure

The State-Trait Anxiety Inventory (STAI) (Spielberger, Garsuch & Lushene, 1970) was used to measure both trait and state anxiety. The anxiety-trait scale was used to discriminate between the low and high A-Trait subjects at the beginning of the research. (See Appendix A for a list of the 20 items.)

A short form of the A-State scale consisting of the five items with the highest item remainder correlations in the STAI normative sample was given every time the subjects were assigned to or asked for a test. The five-item A-State scale was administered by the computer during the learning situation. (See Appendix B for a list of the five items.) These items were used and proven reliable in previous research with an alpha reliability of .87 and .89 (Leherissey, O'Neil&

Hansen, 1971; Leherissey, O'Neil, Heinrich & Hansen, 1973).

Apparatus

The learning material was presented by an IBM 370 (IBM, 1967) computer using Decwriter terminals with regular keyboards. The terminals were located in the computer laboratory, on the fifth floor of the Education Building. There were also many other terminals of the same model available to students around the campus. The CAI system presented the learning material in either learner control or programme control form.

The system also recorded the performance of every subject and the number of trials on every test. It administered the STAI A-State scale (short-form) and recorded the subjects responses. The entire system was functioning under the CAN-7 language, recently adapted for the McGill University System for Interactive Computing (MUSIC, 1978).

Learning Material

The CAI task consisted of an "Introduction to Statistics" programme called "Statis". It contained 16 objectives (see Appendix C) divided between two major topics. Instruction on each objective included a description of the objective and the learning material containing questions and practice examples. For each objective a ten-item test measured mastery. Seven or more questions, answered correctly, indicated that the objective had been mastered. In the programme controlled situation, the students received instruction again upon failure of the test. After the third attempt to master the objective without success, a programme control student was advised to see the instructor for assistance and was signed off. In the programme controlled situation, students had no choice of sequence of instruction or testing; in learner control the subjects had control over the sequence of both the presentation and the testing.

Upon failure of a test, the learner control student could move to another objective and return to the failed objective later; he could also take the test a second time immediately without having to take the instruction a second time. Any sequence of instruction and testing was available to the students. They were, however, advised to seek assistance from the instructor upon failure of the same test a third time, independent of its sequence.

The main difference between programme control and learner control was that learner control subjects could make use of specific keywords to control the presentation of instruction and testing (see Appendix D). However, the learner control subjects were required to take and pass all 16 tests, even if they did not take the instruction. The 16 objectives were completed in six to ten hours and the subjects could sign on and off any time they wished in order to maximize the learner control situation.

Experimental Procedure

On the first day of class, the subjects were given the trait anxiety scale of the STAI and then were told the general purpose of the research. The use of the terminal was explained in detail and students were given a programme to work with that was unrelated to statistics. This orientation program familiarized all students with the terminals and introduced learner control students to the use of keywords. Students were then given one and a half weeks to practice using the terminals. This was intended to ensure that the computer would not frighten the students and thereby influence the results. Upon correction of the anxiety test, the subjects were separated into two groups; half the subjects scoring below the mean on the A-Trait scale and half of the subjects scoring above the mean on the A-Trait scale were assigned to a learner control situation, the other half were assigned to a programme control situation. At the end of the practice period, the students were assigned to their groups and each group met separately with the researcher.

Students were then given more detail concerning their work requirement on the computer, stressing that their performance would contribute to their final grade. The subjects were also told that the research was investigating two different styles of teaching without more detail. They were given the computer code and password, followed by some comments on the keywords that were available to them. Finally, they were told that they had one and a half weeks to (successfully) complete the 16 objectives during which time class meetings were cancelled. The terminals could be used at any time between 8 a.m. and 10 p.m. daily. The instructor was available to the students during class hours and the researcher was available at all times for assistance. The computer presented the learning material according to the program to which the subjects were assigned (learner or programme control). The computer recorded the performance of the subjects on every test, the anxiety score, and the number of trials needed to meet the criterion. At the end of the experiment, the data were analyzed.

CHAPTER THREE

RESULTS

A group of 21 subjects were divided into two groups according to their A-Trait scores (above or below the mean). Half the subjects in each group were randomly assigned to either a programme control or a learner control version of a CAI statistics course. State anxiety and performance were measured throughout the course. Based on the results of this experience, each of the hypotheses on pages 18 and 19 was tested.

Hypothesis 1: Learner Controlled Situation

a) Trait Anxiety will not Predict State Anxiety in the Learner Controlled Situation

A regression analysis was used for this hypothesis. The alternative analysis (ANOVA) would necessitate dividing the subjects into two groups, thereby reducing the degrees of freedom and the power of the test; the regression analysis gives the same results. According to Cronbach:

> The investigator who employs a factorial design can detect some interactions of those conditions he allows to vary, but sizeable interactions are likely to be suppressed, just because any interaction that does not produce a significant F ratio is treated an nonexistent. Unfortunately, enormous volumes of data are required to pin down higher interaction as significant, . . . Hereafter, let us see estimates of variance components and raw-score regression coefficients instead. Confidence intervals will serve adequately to keep us cautious (Cronbach, 1975, p. 124).

For these reasons, regression analysis was used to test this, and subsequent, hypotheses.

Based on Table 1, the hypothesis was accepted $p < .05$). This indicates that for high and low A-Trait subjects, the same level of A-State was recorded in learner control. Or, in other words, A-State did not predict A-Trait in the learner controlled situation.

Table 1

State Anxiety Level for High and Low Trait Anxiety Subjects in Learner Control

	B	se(b)	R^2		
	0.62830	0.08421	0.39476		
Source	df	SS	MS	F	p
Regression	1	18.88734	18.88734	5.21795	$< .05$
Residual	8	28.95750	3.61969		

b) The subjects will have an Anxiety State Level Lower than Subjects in the Programme Control Situation

To test this hypothesis, a *t*-test was used. A small portion of the error variance in the test may be due to A-Trait; however, since A-Trait did not predict A-State (Hypothesis 1a), and since the main concern was with A-State, this variable was not included in the following analysis.

As seen in Table 2, no significant difference in level of A-State was found between learner control and programme control. The hypothesis was rejected.

Table 2

$\underline{T}$-test for Learner and Programme Control on State Anxiety

	N	$\bar{X}$	s	se	F	p
Programme control	11	8.5218	2.273	0.685	1.03	0.957
Learner control	10	10.5260	2.306	0.729		

c) Trait Anxiety will not Predict Performance in the Learner Control Situation

Results of the regression analysis are summarized in Table 3. The probability of .25 or less permits the acceptance of the hypothesis. This indicates that the A-Trait of subjects in learner control is probably not related to performance.

Table 3

Relation of Trait Anxiety to

Performance in Learner Control

	B	se(b)	R^2		
	0.33734	0.01380	0.11380		
Source	df	SS	MS	F	p
Regression	1	0.09983	0.09983	1.02730	$< .25$
Residual	8	0.77738	0.09717		

d) State Anxiety will Predict Performance in the Learner Controlled Situation, High State Anxiety will Result in Higher Performance

This hypothesis can be considered a "differential prediction hypothesis". As pointed out previously, an ANOVA design would provide an indirect test of this hypothesis, perhaps suppressing the interaction. Therefore, a regression analysis was used to directly test the hypothesis.

Performance was predicted from A-State scores separately for the learner and programme control groups. The slopes (*b*'s) of the two regression lines were then compared, using a *t*-test (Draper & Smith, 1966) in order to determine whether the relationship between performance and A-State varied for the two treatment groups. Since A-Trait was not related to performance (Hypothesis 1c), it was not included in the regression equation. A-Trait and the interaction between A-Trait and A-State may account for a small portion of the error variance; however, interpretation of the results would become complex, perhaps suppressing the hypothesized interaction.

Table 4

Performance and State Anxiety for

Learner and Programme Control

For Programme Control

B	se(b)	R^2
0.26973	0.05603	0.07275

Source	df	SS	MS	F	p
Regression	1	0.11455	0.11455	0.70616	> .25
Residual	9	1.45991	0.16221		

For Learner Control

B	se(b)	R^2
-0.14524	0.04737	0.02109

Source	df	SS	MS	F	p
Regression	1	0.01850	0.01850	0.17239	> .25
Residual	8	0.85871	0.10734		

T-test

Formula: $\beta_1 \pm t\ (N - 1, \alpha) \times s.e.$

β_1 = learner control group

$-\ 0.14524 \pm (10,\ .0005) \times .04737$

$-\ 0.14524 \pm\ .1055404\ =\ -\ 0.0396996$

$-.251 < \beta_1 < -.039 \qquad\qquad -\ 0.2507804$

$\beta_2 = +.26973; \qquad \beta_2 > \beta_1$

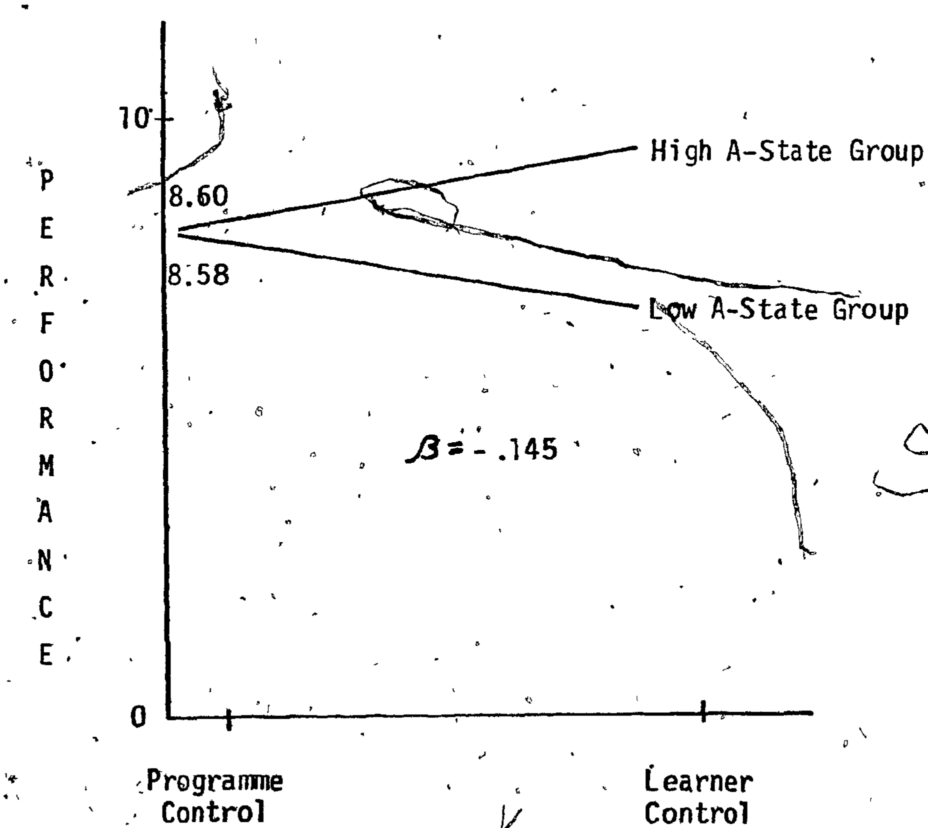

Figure 2. Graph on Beta Analysis.

Hypothesis 2: Programme Controlled Situation

a) Trait Anxiety will Predict State Anxiety in the Programme Controlled Situation. High Trait Anxiety will Result in Higher State Anxiety Scores than Low Trait Anxiety

A regression analysis performed on the data (Table 5) does not permit the acceptance of the hypothesis ($p > .05$). The high A-Trait subjects in programme control respond with a similar level of A-State as the low A-Trait subjects.

Table 5

State Anxiety Level for Low and High Trait Anxiety Subjects in Programme Control

	B	se(b)	R^2		
	0.56987	0.08430	0.32475		
Source	**df**	**SS**	**MS**	**F**	**p**
Regression	1	16.78274	16.78274	4.32849	$>.05$
Residual	9	34.89543	3.87727		

b) The Subjects will have a Higher Level of State Anxiety than Subjects in Learner Control

Since this hypothesis is the inverse of 1b, the results presented in Table 2 were used to test the hypothesis. The predicted relationship between A-State and A-Trait was not confirmed (Hypothesis 2a); therefore, A-Trait was not included in the orginal analysis. Again, a small portion of the error variance may be due to A-Trait, but the main concern of this hypothesis is A-State. No significant difference in A-State scores was found.

c) Trait Anxiety will not Predict Performance in the Programme Controlled Situation

The results were analyzed by a regression analysis. As indicated in Table 6 ($p > .05$), there was no significant relationship between A-Trait and performance; the hypothesis is accepted.

Table 6

Relation of Trait Anxiety to

Performance in Programme Control

	B	se(b)	R^2		
	0.11693	0.01778	0.01367		
Source	df	SS	MS	F	p
Regression	1	0.02153	0.02153	0.12476	>.25
Residual	9	1.55293	0.17255		

d) State Anxiety will Predict Performance in the Programme Controlled Situation, High State Anxiety will Result in Lower Performance than in Learner Control

This hypothesis is the inverse of 1d. As in hypothesis 1d, A-Trait was not included in the regression equation since it was shown to be unrelated to performance (Hypothesis 2c). Table 4 indicates that there is a significant difference between the two prediction equations. This implies that subjects in programme control with a high A-State do not perform as well as the subjects in learner control.

CHAPTER FOUR

DISCUSSION

In the learner controlled situation,it was found that: (a) A-State was unrelated to A-Trait; (b)A-Trait was unrelated to performance,and (c) the high A-State subjects performed better than those in the programme control group. In the programme controlled situation, A-Trait was related to both A-State and performance. Several variables may have influenced the results which were obtained: technical difficulties, characteristics of the sample, problem in definition of the terms. Each of these will be discussed, results will be related to previous research, and the implications of the present findings will be discussed.

Technical Problems

As mentioned in Chapter Two, CAN-7 was the language used for the presentation of the learning material and the A-State scale. CAN 7 recently evolved from the former and more expensive to operate CAN 6 language and therefore was not free of minor programme errors ("bugs"). These errors resulted in several problems: students occasionally had their run aborted during their work; they encountered some minor calculation and typing errors, and some complications in the signing on procedure. The technical difficulties were as frequent for programme control as for learner control students, since they were language related errors.

The experimenter and a programmer were always available to help students and to make corrections if necessary. It is nevertheless important to mention that this research was intended to be a reproduction of a real-life situation. These difficulties were then normal if we consider that at OISE (Ontario Institute for Studies in Education) programmes that are tested for over two years, sometimes cause problems when used (Cranton, 1976). Also, based on the CAI literature, it appears that such difficulties are to be expected. As for the reaction of the students, some subjects showed or expressed annoyance and others said that they realized that "the machine was not perfect". In conclusion, technical problems may have influenced the results; however, the degree of this influence cannot be determined.

Characteristics of the Sample

A further analysis of the data gave more information about the characteristics of the sample. Table 7 indicates that there is no difference in average A-Trait, average A-State or average performance between males and females. Table 8 indicates that programme control and learner control students took about the same amount of time to go through the entire course.

Table 7

T-test for Males and Females on the Trait Anxiety,

Average State Anxiety and Average Performance

		N	$\overline{X}$	SD	se	t	p
Trait Anxiety	F	11	36.8182	8.612	2.597	.072	0.480
	M	10	34.5000	5.642	1.784		
State Anxiety	F	11	09.8927	2.934	0.885	0.81	0.429
	M	10	09.0180	1.840	0.582		
Performance	F	11	08.6991	0.192	0.058	1.40	0.176
	M	10	08.4880	0.457	0.145		

Table 8

Time Required to Complete the Course

For Programme and Learner Control

		N	$\overline{X}$	SD	se	t	p
Time	Programme control	11	6.4745	1.038	0.313	-0.71	0.486
	Learner control	10	7.0050	2.226	0.704		

Some subjects under the learner controlled situation used the programme as a programme controlled situation. That is, some subjects in learner control did not utilize the opportunity to vary the sequence; they simply followed the logical order used in programme control.

Anxiety scores and performance scores for this group were compared to programme control. Table 9 shows that the average A-State and the average performance of those subjects do not differ greatly from the subjects in programme control.

Table 9

State Anxiety and Performance Averages for Programme Control and Learner Control as Programme Control

		N	$\overline{X}$	SD	se	t	p
Anxiety State	Programme control	11	8.5218	2.273	0.685	-0.66	0.521
	Learner control/ Programme control	3	9.4833	2.030	1.172		
Performance	Programme control	11	8.5636	0.397	0.120	-0.12	0.906
	Learner control/ Programme control	3	8.5967	0.531	0.307		

Finally the subjects who did utilize the learner control options were compared to the programme control groups: again no differences in A-State or performance averages were found (see Table 10).

Table 10

State Anxiety and Performance Averages for

Learner Control and Programme Control

		N	$\overline{X}$	SD	se	t	p
A-State	Programme control	11	8.5218	2.273	0.685	-2.18	.045
	Learner control	7	10.9728	2.413	0.912		
Performance	Programme control	11	8.5636	0.397	0.120	-0.55	.592
	Learner control	7	8.6543	0.226	0.085		

Those subjects who used the learner control as intended had the general tendency of taking all the learning material in the first topic followed by all the tests, and repeating this sequence for the second topic. Some subjects returned to tests or learning material from previously failed objectives.

In general, we can say that with the exception of three persons, the learner control situation was used as intended.

Results

How does this information help in the analysis of the results? Refering back to the results section, the data showed no difference in A-State level for programme and learner control. By examining the means of the two groups, the learner control students are seen to have a higher A-State level than the subjects in programme control. Spielberger's theory of state-trait anxiety theory led to the prediction of a lower level of A-State for learner control because learner control is supposedly less threatening, or more likely to result in good performance. Therefore, in our situation, the learner control subjects might have seen the situation as more threatening because of the possibility of errors with the use of the keywords.

Insecurity with the computer or the technical difficulties might also have triggered this anxiety. The complexity of the task is another variable that might have created this same level of A-State for both groups. One or all of these variables could be the cause of this situation, it might also be some other unknown variable(s).

Collier, Poynor, O'Neil and Judd (1973) found a lower A-State for learner control subjects according to Spielberger's theory. But Judd, Daubek and O'Neil (1975) and Judd et al. (1974, part 1 & 2) did not find a reduction of A-State when subjects were using learner control as compared to programme control. We therefore note contradictory findings in the literature and in this study.

The four major problems cited in Chapter Two can explain the confusion: (a) the lack of consensus as to the definition of learner control; (b) a lack of attention to individual differences in the use of learner control; (c) the absence of evidence that the instructional variables placed under learner control have an appreciable effect on learning; and (d) a lack of specificity in measures of the presumed affective advantages of learner control. These experimental issues most likely account for the differences between the results of this study and previous research.

Results confirmed the hypothesis that A-Trait would not be related to A-State in the learner controlled situation. This agrees with Spielberger's theory of state-trait anxiety and with the findings of O'Neil (1969) and O'Neil, Hansen and Spielberger (1969).

The prediction of no relation between A-Trait and performance was also supported by our results for programme control and for learner control. The hypotheses were based on the joint effect of Drive Theory and Speilberger's Theory of Anxiety. The literature also supports this view (O'Neil, 1969; Leherissey, O'Neil & Hansen, 1971; Judd et al., 1975). Contrary to the prediction, the high A-Trait subjects did not respond with higher level of A-State than low A-Trait subjects in the programme control situation. This hypothesis was based on Spielberger's theory that high A-Trait subjects will appraise the situation in programme control as more threatening than low A-Trait subjects, leading to a higher level of A-State for the high A-Trait subjects. The results might be influenced by the difference that existed in the learner and programme control situations, by the technical difficulties that were encountered, or because the situation was not appraised to be as threatening as it was believed to be. Referring back to the first hypothesis (1b), it is seen that learner control subjects seemed to find their situation as threatening as in programme control or more so, and inversely programme control subjects did not find that their situation was a threat.

Here again, the same four research problems mentioned earlier may account for contradictory results. That is to say: (a) lack of consensus as to the definition of programme control; (b) lack of attention to individual differences in the use of programme control; (c) the absence of evidence of no appreciable effect of programme control; and (d) a lack of specificity in measures of the presumed disadvantages of programme control.

The most important hypothesis for further application of this work has been accepted at a very high level of probability. In fact, the results show that the high A-State subjects in learner control performed better than the high A-State subjects in programme control. Spielberger's Anxiety Theory and the Drive Theory are supported once more with this hypothesis. The actual difference presented by the results is very large. This effect could be due to the fact that learner control had a higher level of A-State than expected (Hypothesis 1b) leading to a wider difference in performance compared to low A-State. Figure 2 shows large differences in performance for high and low A-State in learner control and no difference between high and low A-State in programme control. We can also note that the subjects with low A-State in learner control achieved a much lower level of performance than either high or low A-State subjects in programme control. We can therefore say that someone with a low A-State score who is involved with a CAI task, should be assigned to programme control instead of learner control if we want this person to have the best performance possible.

In conclusion, the learner controlled situation seemed to be more threatening than the programme controlled situation and this led to more variation in performance for learner control than for programme control. Performance was highest for the high A-State in learner control followed by the high and low A-State in programme control, and finally the low A-State in learner controlled had the lowest performance scores.

Practical Applications

The present results could assist in assigning students to either a learner controlled or programme controlled situation when using a CAI learning task. To ensure the best possible performance of a student, we could take his or her average measure of A-State in a pre-test situation (e.g., while learning how to use the terminal) and then use this measure to assign the student to learner control if he has a high average level of A-State or to programme control if he has a low average level of A-State. Programming costs for the development of these two options is minimal and, overall, students performance may be greatly improved.

It may be possible to raise the general state anxiety of the students if only the programme control option was available. This anxiety stimuli should not be too provoking (e.g., this CAI course is worth 90% of the total mark), and it would need to be continuous or long-lasting.

It is important, however, to keep in mind that high performance might not transfer to other uses of statistical knowledge and we have to ensure that if we improve performance on a CAI task, we also improve understanding in a non-CAI situation.

Implications for Further Research

Recurrent through this and previous research is the important concern regarding the lack of definition of the programme and learner control situations. It is necessary to determine a clear cut definition of both kinds of programming so that results from further research can be compared. Moreover, the structure and complexity of the task should be taken into consideration when comparing results. It is important to analyze results keeping this in mind.

It has been shown that other personality variables influence the CAI performance (White & Smith, 1974). Also, anxiety is correlated with measures such as agression,autonomy and dominance (Spielberger et al., 1970). Future research should take these relationships into consideration. It is also suggested that future research should take place over a longer period of time so as to give programme and learner control students the time to adapt more to their situation. We said earlier that high performance should involve transference, future research should look at the ability to apply knowledge outside of the CAI task and the relation to performance.

Summary

In this research we looked at anxiety level and programme structure as predictors of performance in a computer-assisted instruction situation. Twenty-one students in a statistics class were tested on their trait anxiety level and then separated into two groups according to their anxiety level. Half of each of these groups were then assigned to either programme control or learner control. While they were taking the course, their anxiety levels and their performance were recorded. The results showed that anxiety trait was not related to perfomance but that students with high anxiety state performed better in learner control situation than in the programme controlled situation. The relation found between anxiety state and programme structure in other studies was not found here.

References

Bachor, D. G. Effect of stress, task and I.Q. on anxiety. Calgary: University of Calgary, 1973.

Bachor, D. G. The effects of stress, task structure and intellect on situation anxiety. Western Psychologist, 1973, 4, 98-103.

Collier, R. R., Poynor, L., O'Neil, H. F., & Judd, W. A. Effect of learner control on performance and state anxiety in a computerized concept learning task. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, 1973.

Cranton, P. A. The interaction of learner characteristics and degree of structure in CAI. Doctoral dissertation, University of Toronto, 1976.

Cronbach, L. J. Beyond the two disciplines of scientific psychology. American Psychologist, February, 1975, 116-127.

Denny, J. P. Anxiety and intelligence. Journal of Experimental Psychology, 1966, 72, 596-602.

Draper, N., & Smith, H. Applied regression analysis. New York: John Wiley & Sons, Inc., 1966.

Fishman, E. J., Keller, L., & Atkinson, R. C. Massed versus distributed practice in computerized spelling drills. Journal of Educational Psychology, 1968, 59, 290-296.

Gallagher, P. D. An investigation of instructional treatments and learner characteristics in a computer-managed instruction course. Florida State University: CAI center technical report #12, 1970.

Hansen, J. B. An investigation of cognitive abilities, state anxiety and performance in a CAI task under conditions of no feedback and learner control. Paper presented at the annual conference of the American Educational Research Association, Chicago, 1972.

Hawkes, T. H., & Furst, N. Race, socio-economic situation, achievement, I.Q. and teachers ratings of student's behavior as factors relating to anxiety in upper elementary school children. Sociology of Education, 1971, 44, 333-350.

Hughes, J. B., Sprague, J. L., & Bending, A. W. Anxiety level, response alteration and performance in serial learning. Journal of Psychology, 1954, 38, 421-426.

Hull, C. L. Principles of behavior. New York: Appleton-Century, 1943.

International Business Machines Corporation. IBM 1401, 1440, or 1460 operating system. Computer assisted-instruction. New York: IBM, 1967.

Judd, W. A. Learner controlled computer-assisted instruction. Paper presented at the international school on computer in education, Pugnochinso, Italy, 1972.

Judd, W. A., O'Neil, H. F., & Spelt, P. F. Individual differences and learner control: II Investigation of control over pictorial mediators in computer-assisted instruction. U.S. A.F.H.R.L. Technical Report, 1974, 73, 1-72.

Judd, W. A., O'Neil, H. F., & Spelt, P. F. Individual differences and learner control: I Program development and investigation of control over mnemonics in computer-assisted instruction. U.S. A.F.H.R.L. Technical Report, 1974, 74, 1-120.

Judd, W. A., Daubek, K., & O'Neil, H. F. Individual differences in learner controlled CAI. Paper presented at the annual meeting of the American Educational Research Association, Washington, 1975.

Kamin, L. J., & Fedorchack, O. The Taylor scale, hunger and verbal learning. Canadian Journal of Psychology, 1957, 11, 212-218.

Leherissey, B., O'Neil, H. F., & Hansen, D. N. Effect of memory support on state anxiety and performance in computer-assisted learning. Journal of Educational Psychology, 1971, 62, 413-420.

Leherissey, B., O'Neil, H. F., Henrich, D. L., & Hansen, D. N. Effect of anxiety, response mode, subject matter, familiarity and program length on achievement in computer-assisted learning. Journal of Educational Psychology, 1973, 64 (3), 310-324.

Lucas, J. D. The interactive effects of anxiety, failure and intra-serial duplication. American Journal of Psychology, 1952, 65, 59-66.

McGill University System for Interactive Computing (MUSIC) (IBM IUP 5796-AJL). McGill University, Montreal Canada, 1978.

Montague, E. K. The role of anxiety in serial rote learning. Journal of Experimental Psychology, 1953, 45, 91-96.

O'Neil, H. F. Effect of stress on state anxiety and performance in computer-assisted learning. Florida: Florida State University, 1969

O'Neil, H. F., Spielberger, C. D., & Hansen, D. N. Effects of state anxiety and task difficulty on computer-assisted learning. Journal of Educational Psychology, 1969, 60, 343-350.

O'Neil, H. F., Hansen, D. N., & Spielberger, C. D. Errors and latency of response as a function of anxiety and task difficulty. Paper presented at the American Educational Reserach Association, Los Angeles, 1969.

O'Neil, H. F. Effects of stress on state anxiety and performance in computer-assisted learning. Journal of Educational Psychology, 1972, 63, 473-481.

Ontario Institute for Studies in Education, Department of Computer Applications. Computer-assisted instruction for colleges of applied arts and technology. O.I.S.E.: Lomberg and Olivier, 1974.

Ontario Institute for Studies in Education, Department of Computer Applications. Computer-assisted instruction for colleges of applied arts and technology. O.I.S.E.: Carrol, M. P., 1975.

Raymond, C. K. Anxiety and task as determiners of verbal performance. Journal of Experimental Psychology, 1953, 46, 120-124.

Saranson, I. G. Empirical findings and theoretical problems in the use of anxiety scales. Psychological Bulletin, 1960, 57, 403-415.

Spence, K. W. A theory of emotionally based drive(D) and its relation to performance in simple learning situations. The American Psychologist, 1958, 13, 131-141.

Spence, K. W. Anxiety (Drive) level and performance in eyelid conditioning. Psychological Bulletin, 1964, 61, 129-139.

Spence, J. T., & Spence, K. W. The motivational components of manifest anxiety: Drive and Drive stimulus. In C. D. Spielberger ed. Anxiety and Behavior. New York: Academic Press, 1966.

Spielberger, C. D. Anxiety and behavior. New York: Academic Press, 1966.

Spielberger, C. D., & Smith, L. H., Anxiety (Drive), stress and serial-position effects in serial learning. Journal of Experimental Psychology, 1966, 72, 589-595.

Spielberger, C. D. The trait-state anxiety inventory. Palo Alto, California: Consulting Psychologist Press, 1968.

Spielberger, C. D. The effect of anxiety on computer-assisted learning. Paper presented at a conference on "The affective domain in learning", Salishan, Oregon, 1969.

Spielberger, C. D., Lushene, R. E., & McAdoo, W. G. Theory and measurement of anxiety states. In Cattell, R. B., ed. Handbook of modern personality theory. Chicago: Aldine, 1969.

Spielberger, C. D., Gorsuch, R. L, & Lushene, R. E. Manual for the state-trait anxiety inventory. Palo Alto, California: Consulting Psychologists Press, 1970.

Spielberger, C. D., O'Neil, H. F., & Hansen, D. N. Anxiety, drive theory and computer-assisted instruction. In Maher, B. A., ed. Progress in experimental personality research. New York: Academic Press, 1972.

Spielberger, C. D. Anxiety: Current trends in theory and research. New York: Academic Press, 1973.

Steinberg, E. R. Review of student control in computer-assisted instruction. Journal of Computer-Based Instruction, 1977, 3, 84-90.

Taylor, J. A. A personality scale of manifest anxiety. Journal of Abnormal and Social Psychology, 1953, 48, 284-290.

Taylor, J. A., & Chapman, J. P. Anxiety and the learning of paired-associates. American Journal of Psychology, 1955, 68, 671.

Taylor, J. A. Drive theory and manifest anxiety. Psychological Bulletin, 1956, 53, 303-320.

Tobias, S., & Duchastel, P. C. Behavioral objectives, sequence and anxiety in CAI. Instructional Science, 1973, 3, 231-242.

White, A. L., & Smith D. D. A study of the effect of varying student responsibility for instructional decisions in a CAI course. Journal of Computer-Based Instruction, 1974, 1, 13-21.

PREVIOUSLY COPYRIGHTED MATERIAL,

IN APPENDIX A, LEAF 50,

NOT MICROFILMED.

SELF-EVALUATION QUESTIONNAIRE

STAI FORM X-2

SPIELBERGER, C.D. THE TRAIT-STATE ANXIETY INVENTORY. PALO ALTO, CALIFORNIA: CONSULTING PSYCHOLOGIST PRESS, 1968.

Appendix B

The Five Item A -State Scale

The five items A-State scale administered were:

1 - "I am tense"

2 - "I feel at ease"

3 - "I am relaxed"

4 - "I feel calm"

5 - "I am jittery"

The subjects responded to each item by rating themselves on the following four-point scale:

1 - "not at all"

2 - "somewhat"

3 - "moderately so"

4 - "very much so"

Appendix C

Statistics List of Topics

Topic 1: Measures of Central Tendency

1.1 Average
1.2 Arithmetic Mean
1.3 Relation of Mean to Frequency Distribution
1.4 Changing the Origin, changing Units
1.5 Some properties of the Mean
1.6 The sample Mean as an Estimate
1.7 Median
1.8 Mode
1.9 Comparison of Mean, Median and Mode

Topic 2: Measures of Variability

2.1 Variability
2.2 Range
2.3 Variance
2.4 Standard Deviation
2.5 Relation of Standard Deviation to Frequency Distribution
2.6 Properties of the Standard Deviation
2.7 The sample Standard Deviation as an Estimate
2.8 Standard scores

Appendix D

List of Commands

Learner Control Commands

I x.y	:	instruction on topic x, objective y
TX	:	tests on all objectives in topic X
T x.y	:	test on topic x, objective y
STOP	:	return to normal execution of the programme
SOS	:	lists control words
GLO	:	accesses glossary
TOP	:	lists topics
COM	:	enter a comment
CALC	:	enter calculation mode
List	:	list options
T Left	:	list of tests you have not done, or failed
I Left	:	list of instructions you have not done, or failed
LES	:	introductory lesson to the use of the terminal

Programme Control Commands

COM	:	enter a comment
TOP	:	list the topic
GLO	:	use of glossary
CALC	:	enter calculation mode
STOP	:	return to normal execution of the programme
LIST	:	list option