THE EFFECTS OF TWO MODES OF PRESENTATION OF A COMPUTER ASSISTED LEARNING ENVIRONMENT ON STUDENTS' PERFORMANCE AND LOCUS OF CONTROL

by

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ABSTRACT

The study investigates the effects of two modes of presentation of a computer assisted learning environment on students' performance and perceived locus of control. Fifty-five subjects were randomly assigned to one of two treatment groups where treatments differed in degree of structure. Students in treatment 1 were required to stipulate whether they wanted to practise or to take a test; students in treatment 2 were not required to make this distinction. Locus of control was measured once prior to treatment and three times during treatment. No interaction was found between mode of presentation and locus of control or between mode of presentation and performance. Overall changes in locus of control scores towards the Internal pole were noted. Externally oriented students exhibited significantly greater changes than internally oriented students.

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RESUME

Cette étude recherche les effets de deux modes de présentation de l'apprentissage informatisé. Les performances des étudiants ainsi que leur perception du contrôle dans le milieu ("locus of control") ont été examinées. Cinquante-cinq étudiants ont été assignés au hasard à un des deux groupes de traitement où ces deux se sont différenciés selon le degré de structure du traitement. Dans l'un des traitements, les étudiants devaient stipuler s'ils voulaient pratiquer ou s'ils voulaient subir un test. Dans l'autre traitement, on n'a pas exigé des étudiants qu'ils fassent ce choix. Le "locus of control" a été mesuré une fois avant le traitement et trois fois pendant le traitement. On n'a découvert aucune interaction entre le mode de présentation et le changement du "locus of control," ou entre le mode de présentation et la performance. On a observé des changements généraux dans le "locus of control" vers le pôle interne. Des étudiants ayant une orientation externe ont démontré des changements sensiblement plus important que ceux ayant une orientation interne.

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D.D.

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CHAPTER I

INTRODUCTION

During the last decade, computer assisted instruction has evolved into a prominent educational medium. Its use has proved relevant throughout all sectors of the school system, ranging from the primary to the university levels. In the past, educational researchers have concentrated on comparison of the traditional classroom with the computer assisted environment or on comparison of various modes of presentation such as learner control and machine control within the computer assisted setting. More recently however, researchers have focused on the interaction between characteristics of the individual (referred to as "learner characteristics") and the type and/or structure of the computer assisted environment utilized. The computer provides an excellent tool for the investigation of interactions by offering the researcher the use of an actual instructional setting combined with the benefit of strict control over the environment.

In the investigation of interactions between the individual and his educational environment, the learner characteristic of locus of control[1] has been shown to interact with

the degree of structure in the instructional setting. Most of these studies have been carried out in the classroom situation while to date, few have explored the computer assisted environment.

The present study was designed to investigate the interaction between the students' learner characteristic of locus of control and the degree of structure provided in the computer assisted environment.

CHAPTER II

REVIEW OF THE LITERATURE

Relevant literature in a number of areas will be discussed. First, a general description and overview of the methodology utilized in the investigation of interactions between the individual and his environment (more generally referred to as person by environment studies) will be presented. Secondly, the advantages of conducting person by environment studies using a computer assisted medium will be discussed. Finally, relevant empirical studies pertaining to the degree of structure of educational instruction and studies dealing with pertinent learner characteristics will be presented and reviewed.

Overview of the Aptitude-Treatment Interaction Model: Definition and Methodology

Historically, educational research has developed along two parallel lines, the "experimental" and the "correlational." Experimental researchers traditionally have dealt with overall differences in learning by varying instructional methods or policies in an attempt to establish general laws of learning whilst correlational researchers have focused on individual

differences by examining the relationships between various learner characteristics.

L. J. Cronbach (1957), in his Presidential Address to the American Psychological Association, advocated an amalgamation of the two perspectives into one, i.e., an aptitude-treatment interaction approach (ATI). He thought that maximization of the educational process could be attained by consideration of the interplay between instructional methodology and learner characteristics.

The most recent and most widely accepted definition of an aptitude-treatment interaction is that outlined by Cronbach and Snow in 1977, where they broadly define an "aptitude" as any characteristic of a person which forecasts his probability of success under a given treatment. This definition includes personality and ability, as both are factors which influence an individual's response to a given type of instruction. "Treatment" refers to any manipulable variable and "...when a characteristic cannot be manipulated (e.g., teacher sex), the student's experience can be manipulated by an assignment policy" (p. 6). In short, an aptitude is a characteristic of the individual which can be affected by a manipulated treatment such as method of instruction or age and sex of the teacher giving the instruction.

As early as 1935, Kurt Lewin made a classic interaction statement in the field of personality when he stated that

B = f (P, E); i.e., Behaviour is the function of Person and the Environment. This statement has been frequently criticized for its lack of precision of the variables involved. Subsequent elaboration of this basic premise in the educational sphere has resulted in more specific statements of the issue by Cronbach and Snow (1969, 1977), and Hunt (1971).

According to Cronbach and Snow, an aptitude-treatment interaction occurs when the effects of a treatment vary among groups of individuals possessing different characteristics or aptitudes. They emphasize that interactions should be statistically represented by regression equations for each treatment. An interaction is present when the slopes of the regression lines are significantly different (Cronbach, 1975; Cronbach & Snow, 1969, 1977; Snow, 1976).

Interactions are classified as "ordinal" or "disordinal." An ordinal interaction is present when the regression lines are non-parallel but do not intersect within the range of the aptitudes. A disordinal interaction is present when the regression lines do intersect within the aptitudes measured. Until recently, only disordinal interactions were considered valuable in decisions regarding the advantage of one treatment rather than another for a specified group of individuals. The ordinal interaction was considered to be of little, or marginal value in predicting the dependent variables and came to imply that the same treatment produced equal effects on all subjects

(Cronbach & Snow, 1965, 1977). Cronbach and Snow (1977) have reconsidered this stance and now emphasize the need to further investigate ordinal interactions. They state that although the regression lines may not cross each other for a fixed sample, they may cross somewhere outside the range of the specific sample.

Traditionally, equations have utilized an aptitude as independent variable and a specific learning criterion as dependent variable. More recently however, Cronbach and Snow (1977) and Snow (1976, 1977) point out that the interaction effects may work in reverse. An individual's aptitude may change because of the treatment effects thus, the aptitude becomes a dependent variable as well.

Bracht (1969, 1970) reviewed and classified 90 ATI studies on the bases of aptitudes measured, treatments utilized, and interactions reported. Of these studies only five yielded disordinal interactions, and four of the five utilized "factorially simple" aptitude measures. The five studies involved treatments which were clearly stated and well defined. Bracht's devastating review caused many researchers to question the usefulness of continuing ATI research; for example Glass (1970) stated that: "There is no evidence for an interaction of curriculum treatments and personological variables" (p. 210). He further added that if any interactions did exist they did so with respect to very narrow and specific variables and not

general measures such as I.Q.

At the time of Bracht's review it was generally agreed among researchers that only disordinal interactions could be considered of value. Bracht however, applied such a stringent test for disordinality that relatively few reported results could be classified as disordinal. With the more recent emphasis on the need to reconsider ordinal interactions, many more of the studies reviewed by Bracht could be seen to support the existence of ATI (Cronbach & Snow, 1977).

Major criticisms of the ATI literature to date have focused upon the following points:

1. The design of the research has been weak and often the investigation of the interactions has not been considered in the design.

2. Treatments have been extremely brief or artificial.

3. Aptitudes and treatments have been chosen with no theoretical or practical basis.

4. Statistical analysis of the data has been weak and incorrect at times.

5. There has been a general lack of replication of the results (Cronbach & Snow, 1977; Shapiro, 1975; Snow, 1976).

However, inconsistent results in the ATI research are not due solely to poor technique (as stated in points 1-4). Cronbach (1975) attributes a large part of the inconsistency between studies to unidentified, or "higher-order" interactions.

These are interactions which are not confined to the first order but which are extremely complex. The classroom dynamics include the aptitudes of the students and the instructional methodology, as well as such factors as the personality and sex of the teacher, the dynamics between personalities of the students, etc. The aptitude by treatment effect may not tell the whole story if aptitude by treatment by sex of the teacher interact. Therefore, lack of replicability between studies may not refute the existence of ATI but rather may indicate the presence of higher-order interactions.

It is evident that further research in the area must include a detailed study of the aptitudes involved, the nature of the learning task, and a sound theoretical basis for the choice of treatments (see also Cronbach, 1975, Cronbach & Snow, 1977).

The Learner, Instructional Treatments, and the Learning Task

There has been much controversy over the use of "general" versus "specific" learner characteristics in ATI. Cronbach and Gleser (1965) stated that tests of general ability were less likely to be useful in dealing with educational decisions pertaining to individual differences than the highly specialized tests. Others agreed with this statement (cf. Glass, 1970; Bracht, 1970) and educational researchers began to

investigate ATI utilizing more specific aptitude measures. More recently however, general ability measures have been found to be better predictors of the amount learned or the rate of learning than specific abilities (Cronbach & Snow, 1977, Snow, 1976). General measures include "g," I.Q., scholastic aptitude, nonverbal reasoning, grade point average, etc. Highly specific measures of ability such as Guilford's 120 factors have not proved to be successful predictors, but somewhat more general (but still "special") measures such as Cattell's "fluid" and "crystallized" intelligence or Jensen's two levels of intellectual functioning, may prove to be of better predictive value.

When personality variables are used as "aptitudes" (as discussed above, p. 4) it is essential to assess their validity over the course of the treatment. Although "trait" psychologists have traditionally thought of personality in terms of stable unchanging dimensions, it is important to reassess the personality variables while the individual is in the learning environment. As mentioned previously (see p. 6) treatments may affect the characteristics of the individual, an issue which will be discussed in more detail in the section dealing with ATI studies utilizing personality variables.

Cronbach and Snow (1977) emphasize that treatments should be of long-duration and should be carried out in a

natural instructional setting where the students' responses to actual educational treatments can be measured. Difficulties arise with the use of contrived experimental studies, especially those of short-duration, because they cannot be generalized to the classroom. In addition, selection of the treatments should be based on stated theoretical grounds, and an analysis of the learning task could be conducted to facilitate the choice of appropriate instructional treatments and relevant aptitudes.

Analysis of the learning task, or task analysis, becomes an essential part of ATI research if we are to identify the aptitudes and levels of learning that are relevant to a specific task. Task analysis refers to an analytic description of what is to be learned and "...is characterized by the description of tasks in terms of the demands they place on such basic psychological processes as attention, perception and linguistic processing" (Gleser and Resnick, 1972, p. 209).

Cronbach and Snow (1977) discuss two methods of task analysis which appear to be adaptable to the ATI paradigm. One approach is a behavioral analysis of tasks which Gagné (1974) has applied to the educational setting. Gagné breaks a task into smaller behavioral components or learning objectives, and determines the hierarchy of learning involved, i.e., what the student must know in order to move from one step to the next. Each step in the hierarchy is defined as

an observable behavior. This model allows for individual differences since the learners may begin a task at different points of the hierarchy, omit unessential branches, and/or omit steps where knowledge already exists.

The second approach to task analysis is based on the information processing model. A flow chart is devised which outlines the sequence of decisions and operations which are involved in a specific task. The investigator asks what alternatives, sequences, storage facilities, etc. are possible at a given point. Subsequently, the investigator asks in what way effective and ineffective learners differ in the sequence of decisions or operations utilized. Identification of the aptitudes involved in the completion of a task could be outlined and individual differences taken into account by means of the various treatments.

Cronbach and Snow outline three possible ways in which aptitudes and treatments can be matched: "capitalization of strengths," "compensation," and "remediation." Capitalization of strengths involves placing the learner in a treatment that attempts to maximize his assets. For example, some theorists hypothesize that learners who score highly in verbal ability will respond best when given a highly verbal treatment or that students who score highly in spatial ability will do best when given many diagrams. The same reasoning may be applied to the personality domain. For example, students

who generally feel in control of the environment may perform best when given control of their educational environment. The basis of this approach is to match the treatment and aptitudes so that they are congruent. A second form of matching may be referred to as compensation. Here the treatment does for the learner what the learner cannot do for himself. For example, learners who are poor readers could have the material presented auditorily; those with poor organizational skills could have the instructional material organized for them. A third form of matching is remediation. This process involves overcoming the learner's weaknesses rather than compensating for them. A variant has been introduced by Salomon (1971) who proposes the "preferential" model in which the instructional treatment is designed to capitalize on the learner's preferred style and/or strengths. This approach differs slightly from the capitalization of strengths discussed by Cronbach and Snow in that preferred styles may not necessarily involve areas of strength.

Hunt (1970, 1971, 1975) proposes an alternate approach, a conceptual level matching model. This model attempts to match the degree of structure in the instructional environment to the student's learning style. Learner characteristics are considered in terms of conceptual level or conceptual complexity which is assessed by the Paragraph Completion

Method and scored on the basis of underlying conceptual structure or development. Hunt defines conceptual development as a continuous process which can be broken down into stages. In Stage A the individual is self-centered, and not yet aware of cultural and social standards. In Stage B the individual is dependent upon others and conforms. As the person moves on to Stage C he becomes less dependent and more reliant upon himself.

The relevant treatment variable for Hunt's conceptual level is the degree of structure in the instructional setting. The degree of structure may be defined in a number of ways: discovery methods versus traditional techniques; teacher control versus student control; highly structured teachers versus unstructured teachers; machine control versus learner control; and so on. In reviewing studies of person by environment effects in education Hunt (1975) concluded that failure to incorporate a developmental perspective on the degree of structure required to complete a task was the downfall of many interaction studies in the field of education. His own approach requires that periodic measures of the variables be taken throughout the course of the treatments.

The Usefulness of the Computer Assisted Environment in Conducting ATI Studies

The computer is fast becoming an efficient and economical

medium of instruction and most likely will continue to evolve as a prominent educational tool. Computer assisted instruction (CAI) offers the researcher an excellent vehicle for the study of person by environment interactions. Treatments can be clearly defined and executed by the computer. Such precise methods alleviate the problems that arise in training teachers to carry out specific treatments. Exact replication of treatments through programming enables the researcher to compare results of one study with another. Random assignment of individuals to treatments can be carried out with greater facility than when dealing with classes as a whole. Aptitude variables can be measured during the course of instruction and changes in learner characteristics could be incorporated into various branching procedures of the treatments. Data collection can be automatically carried out and stored for further analyses. CAI allows the researcher the benefits of experimental rigor and at the same time offers the experimenter the use of an actual instructional setting.

Several educators have argued that CAI provides a useful means of conducting ATI research and of implementing individualized instruction. Britt (1977) for one, advocates modelling the structure of CAI upon "learner types" which are classified on the basis of an individual's response patterns to instructional tasks. Response patterns illustrate

the instructional needs of the learner and can subsequently be matched with the structure of a program. Matching of this kind would first necessitate a decision as to the function of "the match" - remediation, compensation, preference, or capitalization of strengths.

Merrill (1975) warns against adaptation of the environment to the individual's needs by sources other than the learner. He states that, "an adapting-to-the-student procedure will make the student system-dependent. Our goal ought rather to be to make the student system-independent. Students ought to be able to learn better after experience with the system than they could before" (p. 222). He proposes that students be taught to manipulate the system and to adapt the environment to themselves. He suggests the learner be given, at appropriate intervals, a selection of tactics he can use to approach the task. Each learner would be able to choose that tactic which would facilitate his progress in the task. The learner would be able to experiment with alternate tactics and choose the one which facilitates completion of the task. In this manner, the learner modifies his own educational environment.

An example of this type of self-adaptive program is TICCIT (Two-way Interactive Computer Controlled Information Television). This program was developed in an attempt to implement a learner-controlled CAI system which allows the

user a choice among various tactics. This approach differs from that of a traditional ATI design in that it does not necessitate determination of aptitudes prior to instruction. One criticism of the program is that it allows the learner to continue following tactics which may not be the most efficient.

Bell (1974) emphasizes that computer-related instruction should be student controlled to maximize its effects. He states that one reason why CAI may be so successful is that the student perceives it as different from the traditional classroom environment (Hawthorne effect). In contrast to the classroom, CAI involves a one-to-one interaction initiated and terminated by the student himself. In order to capitalize on this difference, student control must be maximized.

Bell's view may be somewhat simplistic, for if novelty was the major reason for success with CAI one would expect this effect to decline over time. There is no such evidence to date. He may be accurate in pinpointing the element of student control as a factor which contributes to the success of CAI. In general, however, no significant differences have been found between learner control and machine control when no other variables were taken into account (cf. Newkirk, 1973).

Bell also discusses the potential of computer-based learning to transform the testing situation into a learning

experience. One such system is ICAT (Interactive Computer Assisted Testing) which is currently used in the Educational Psychology Department of McGill University. ICAT administers a quiz individually to each student and immediately gives the user feedback on his response to each question. The user can request further information on the subject and is subsequently presented a feedback paragraph which includes an explanation of the correct response and a reference to a page in the textbook. By providing the correct results the testing situation evolves into a learning situation. This hypothesis was confirmed by results of a study conducted by Cartwright and Derevensky (1977-78). They found that towards the end of the school year students perceived the quizzes, which comprised 35% of their total grade, as more a means of learning than a means of evaluating their progress. In an earlier study (cf. Cartwright and Derevensky, 1976) students reported learning more from the quizzes than from traditional classroom tests. The results of this study were found prior to the addition of the feedback paragraphs. A more detailed review of ICAT has been provided by Hausman (1978).

ICAT, a subset of CAI, offers the researcher an excellent opportunity to investigate interactions between the individual and his environment. Depending upon the manner of presentation, these interactions can be investigated utilizing ICAT

as strictly a learning situation (practice runs), a testing situation, and/or both a learning and a testing situation.

Review of Pertinent Empirical Research

Research in both the CAI setting and the traditional classroom has indicated that several personality and ability variables consistently interact with instructional methodology. Those variables relevant to the present study will be discussed, and the supporting research presented.

A considerable amount of research has focused on the role of anxiety in the CAI setting. Spielberger (1969) developed a two-dimensional construct of anxiety ("trait-anxiety" and "state-anxiety"). Trait-anxiety (A-trait) is defined as the individual's proneness to anxiety, whereas State-anxiety (A-state) is defined as the individual's anxiety at a given moment and therefore is situation-specific. A-state is characterized by a highly aroused emotional state. Results of Spielberger's two preliminary experimental studies found A-state to be a better predictor of performance than A-trait. In addition, it was found that performance was the result of the interaction between A-state and task difficulty. These findings were further supported by Lehirissey (1973).

O'Neil (1972) examined the effects of stress on A-state and performance on a CAI mathematical task. Subjects were

female undergraduate students who differed in A-trait and who were randomly assigned to two treatment conditions, a stress condition and a non-stress condition. Results indicated that in the stress condition, high A-trait subjects exhibited a significantly greater increase in A-state than the low A-trait subjects. The level of A-state decreased over time for the high A-trait subjects but remained the same for the low A-trait subjects. In the non-stress condition, changes in A-state were parallel for all subjects. Subjects high in A-state made significantly more errors than the low A-state subjects while engaging in the easier sections of the task but not during the more difficult sections. These results lend further support to Spielberger's findings (cf. Spielberger, 1969).

Tobias and Duchastel (1973) investigated the interaction between anxiety, the use of behavioral objectives, and sequence of presentation. Subjects were undergraduate students enrolled in a psychology class, who were randomly assigned to treatment groups, one of which received instructional objectives and one of which did not. Each treatment involved either a random or a logical instructional sequence. Measures of anxiety were taken prior to the program, during the program, and after the posttest. As hypothesized, no difference was found in posttest anxiety scores between the group which used objectives and the group which did not.

The illogical sequence of frames reduced achievement and increased errors. Contrary to the hypothesis, no interaction was found between the variables; anxiety, objectives, and sequence. The authors reasoned that the highly anxious students would benefit from provision of behavioral objectives and a logical sequence, for it would reduce their anxiety and maintain their attention on task. They thought failure to yield this interaction was due to the fact that subjects did not appear to utilize the objectives which were presented "off-line." A-state may not have increased in the scrambled sequence condition because subjects did not ascribe poor performance to themselves but rather to the illogical sequence. In order to increase A-state the learner must perceive a causal relationship between the self and his poor performance.

The above study illustrates the necessity of ensuring that stated differences between treatments are actually perceived by the students. Presentation of behavioral objectives "on-line" would have ensured that students observed the objectives and would have precisely controlled the exposure time.

Sutter and Reid (1969) investigated the role of anxiety, sociability, and dominance in a CAI mathematical problem-solving course. Subjects were undergraduate males, randomly assigned to treatment groups which involved either working

in pairs or working alone at the terminal. Results supported the proposed hypothesis that no differences were to be found between treatment groups on achievement scores or attitude when personality variables were not taken into account. Subjects high in test anxiety measured by Sarason's Test Anxiety Scale exhibited significantly higher levels of performance when working alone, whereas subjects low in test anxiety exhibited significantly higher levels of performance when working with a partner. Students high in sociability performed significantly better working in pairs, whereas students low in sociability performed significantly better working alone. Subjects high in dominance voiced a negative attitude toward CAI when working in pairs. The authors concluded therefore that when certain personality factors are taken into consideration, working in a CAI setting in pairs can be as efficient as working alone.

The use of anxiety as a two-dimensional measure has yielded relatively consistent and promising interaction effects. It is possible that other personality dimensions could benefit from a similar "trait" and "state" approach. The above mentioned studies exhibit interaction effects of personality "states" with instructional treatments which would not have been apparent utilizing "trait" dimensions alone. Results indicate that it is the "state" measure which interacts with the treatment and predicts achievement,

whereas the "trait" measure is not a good predictor. These studies further exemplify the need to reassess the dependent variables (traits) over time to pinpoint the interaction effects (cf. Cronbach & Snow, 1977; Snow, 1976).

Another area which has been widely studied, particularly at Stanford University, is the interaction between the degree of structure of instructional methodologies and various learner characteristics.

Domino (1968,1971) conducted two studies, one naturalistic and the other experimental. These studies investigated the effects of student personality on method of instruction. In the first study, college students were divided into four groups on the basis of their scores on the Achievement via independence (Ai) and Achievement via conformity (Ac) scales of the California Psychological Inventory. Groups were classified as High (Ai): High (Ac), Lo (Ai): Lo(Ac), Low (Ai): High (Ac), and High (Ai): Low (Ac). Each course that the students followed was classified as either "encouraging conformity" or "encouraging independence." This classification procedure was carried out through structured interviews with each of the instructors. The results of the study indicated that students exhibiting High (AI): Low (Ac) obtained significantly higher grades in the more structured courses. In addition, those students who were High (Ai): High (Ac) generally did better than those who were Low (Ai):

Low (Ac).

The second study conducted by Domino (1971) was a controlled experiment in which High (Ai): Low (Ac) and Low (Ai): High (Ac) extreme groups were identified. The results of this study indicated the same pattern of achievement as in the previous study (cf. Domino, 1968).

Dowaliby and Schumer (1973) investigated the differences between two contrasting styles of teaching a course. These two styles were a "teacher-centered method" and a "student-centered method." In the teacher-centered approach student participation was not encouraged whereas in the student-centered approach student participation was encouraged. For example, students were expected to ask questions and to participate in experimental demonstrations. The researchers found that the more anxious students (as measured by the Taylor Manifest Anxiety Scale) performed significantly better in the teacher-centered group while the less anxious students performed significantly better in the student-centered group.

Peterson (1976) investigated the interaction between student personality and teaching approach by utilizing the aptitude and the treatment variables of the Domino (1971) and the Dowaliby and Schumer (1973) studies. He attempted to separate the effects of teacher structure (as defined by Domino) and student participation (as defined by Dowaliby and Schumer). Treatments were reconceptualized with the

resulting four groups - High Structure: High Participation (HS: HP), High Structure: Low Participation (HS: LP), Low Structure: Low Participation (LS: LP) and Low Structure: High Participation (LS: HP). One teacher taught a two week social science unit to four ninth-grade classes utilizing one of the four instructional treatments per class. The following aptitude measures were obtained: G (based on verbal comprehension), manifest anxiety (obtained from the combined scores on the Children's Manifest Anxiety Scale and the Spielberger State-Trait Anxiety Inventory), Achievement via conformity (Ac) plus Achievement via independence (Ai) and (Ac) minus (Ai). In this manner two variables were defined to distinguish general motivation for achievement from orientation toward independence versus conformity. The resulting measures included immediate and delayed multiple choice questions on the subject matter, an essay test, and an attitude inventory. The results of the study yielded a main effect for G, no main effect for treatment, and two ATI effects. Students exhibiting the High (Ai): Low (Ac) pattern performed best in the LS: LP treatment. The next best treatment for students exhibiting this pattern was the HS: HP treatment. Students classified as High (Ac): Low (Ai) performed best in the HS: LP treatment followed by the LS: HP treatment. Peterson concluded that conforming students benefited from the provision of one clear strategy to which

they could conform, preferably the teacher structure method. The independent students performed best in the unstructured learning situation. An interaction was found between ability (G) and anxiety (Ax), neither (G) nor (Ax) alone interacted with the treatments. For those students who were Low (G): High (Ax) or High (G): Lo (Ax) the LS: LP treatment was by far the better of the two treatments. This treatment was the least beneficial instructional setting for those students who were either low in both aptitudes or high in both aptitudes. These results seem to indicate that both nonanxious students with low ability and high anxious students with high ability need structure imposed by the teacher in order to perform maximally.

The results of this study are of importance because they indicate that the investigation of higher order interactions is a promising area.

White and Smith (1974) investigated the interaction between the degree of learner control and personality types in a course that consisted of six modules on behavioral objectives in education. Students were identified on the basis of their Introversion-Extroversion and Sensing-Intuitive types through administration of the Myer-Briggs Type Indicator and the Sensing-Intuitive Scale. Subjects were randomly assigned to one of four treatment groups. Group A was computer controlled in all dimensions, Group B

had learner control over "recommendations for next component," Group C had control over the "recommendations for next component" as well as "sequencing of modules and activities," and Group D had control over all of the preceding, as well as being provided with "behavioral objectives" for the module. The results of the study indicated that as learner control increased, the Intuitive types became less satisfied with CAI and the Sensing types more satisfied. There was an interaction between the dimension Introversion-Extroversion and the number of errors made in that both Introverts and Extroverts had a tendency to make fewer errors when following the machine controlled program of Group A. These results were most apparent with the Extroverts, whereas error-making by the Introverts was not tied directly to treatment group.

The following studies investigate interactions between treatments varying in degree of structure and a specific learner characteristic - Internal-External locus of control.

Internal-External (I-E) locus of control is a personality dimension first defined by J. B. Rotter in 1966. This dimension measures an individual's perception of the amount of control he has over his environment and events that occur in his life. Internals feel that they are directly responsible for the consequences of their behavior; whereas Externals believe that their reinforcements of behavioral acts are controlled by forces outside themselves, forces such

as fate, luck and/or other persons. The scale devised to quantify this dimension consists of 29 forced-choice items which measure the individual's generalized expectancy for reinforcement. Some theorists hypothesize that those individuals who feel in control of their destiny would prefer and/or benefit from an educational environment which they can control. It is further hypothesized that those who do not feel in control would benefit from an external structure imposed upon them by the instructional method.

Parent, et al. (1973) investigated the interactive effects of two classroom teaching strategies and locus of control on student performance and attitude, where the instructional "material" was a two hour course on computer programming. This study was based on the "transfer of control" paradigm (Forward, 1973, cited in Parent, et al., 1975) which takes into account the "fit" between student characteristics and method of teaching and allows the student reduced control and structure as he becomes more competent and familiar with an area. Subjects in the Parent et al. study were 54 college students who had each been tested on the I-E scale prior to treatment and who were then randomly assigned to one of two treatment groups which differed in degree of structure. The high discipline condition involved teacher control over the structure of the subject matter as well as the conditions of learning in the classroom. The

low discipline condition involved a low degree of teacher control and more freedom on the part of the student to structure his own learning experience. The researchers hypothesized that External subjects would perform better in the high discipline condition and Internal subjects would perform better in the low discipline condition. Subjects were also questioned on their preference for instructional structure. The results confirmed the hypothesis in that Internal subjects performed significantly better in the low discipline condition and External subjects performed significantly better in the high discipline treatment. Additionally, subjects assigned to their preferred condition reported greater satisfaction with the course. No main effects were found for treatment or student characteristics alone. The authors concluded therefore that performance is more a function of "fit" between learning skills (locus of control) and teaching method than a result of preference for a condition.

While the results of the preceding study support the interaction hypothesis, it should be noted however, that duration of treatment was unduly short (a major objection to many research designs noted on page 7 above). Further study implementing lengthened treatments should be undertaken before generalization of results to a natural classroom setting can be made.

Daniels and Stevens (1976) found similar results with a college population. Internal subjects performed significantly better in a "contract for grade" method of evaluation which was learner controlled. External subjects performed significantly better in a teacher controlled method of evaluation. The authors, however, explained the results in McLelland's terms of achievement motivation. Internals were said to perceive consequences as a direct result of their actions, therefore a "contract for grade" method which is learner controlled, should increase achievement motivation. Externals, however, would not be expected to do as well in the "contract for grade" condition because they do not perceive consequences as a direct result of their own behavior.

This particular study did not measure achievement motivation levels, but further research could incorporate measures of achievement motivation into the design to investigate those authors' explanation of their results.

Judd et al. (1974) investigated the impact of learner control in a CAI setting by measuring students' attitudes and performance. They hypothesized that subjects who were Internals and high in Achievement via Independence (Ai) would use the learner control facility more frequently. They reasoned that ". . . the external /sic/ subject could be analogous to the student who has depended on the instructor

or some other external agent to guide his learning and has not perceived his opportunities for control. It appears that increasingly well-defined task instructions provide a cognitive link for externals which helps them to improve their performance" (p. 2). Results indicated that the Locus of Control Scale was not able to predict differential learner control behavior.

Cranton (1977) investigated locus of control (as one personality variable among others) and its interaction with the degree of learner control in a CAI setting. Three separate phases of the study were carried out on different student populations. Although no significant interactions were found in Phases II and III of the study, those students with high Internal scores tended to have lower achievement scores and more negative attitudes when placed in the computer controlled treatment group. Phase I yielded different results in that locus of control did not differentially predict achievement or attitude. However, this may have been artifactually due to methodological problems.

The preceding studies have investigated interaction effects between learner control and locus of control. All of these studies have attempted to "fit" (using a model based on congruence of personality and treatment I-with low structure, E-with high structure) aptitude and treatment.

Inconsistent results which have been reported may be due to: (1) short duration of treatments; (2) contrived treatments; (3) presence of undetected higher-order interactions; and/or (4) failure to reassess the aptitude variables during treatment to check for interaction effects which may have altered the learner characteristics.

The studies reviewed below overcome the last difficulty by attempting to assess changes in locus of control due to the treatment effects.

Fisher and Blackwell (1975) investigated the effects of student control over choice of difficulty level of arithmetic problems in a CAI setting on the locus of control attributes of the subjects. Subjects were 38 fourth and fifth grade students from a low-income area who were randomly assigned to either a choice group or a control group. The locus of control measure, administered after treatment, was designed by the authors and related specifically to mathematical performance. The locus of control measure was divided into four categories: stable/unstable, control/no control, internal/external, and self/other. Results of the study indicated that subjects in the choice group made significantly more attributions to sources controllable by the self. The authors concluded that subjects in the choice group felt that they could control their performance (by effort as well as by choice of difficulty) more than subjects in the control

group. Additionally, the choice group engaged in task behavior significantly more frequently than the control group.

Although data for this study did not include interactive effects between the subjects' locus of control aptitudes and treatments, differential locus of control attributes were reported due to the treatment effects alone.

I. D. Smith (1973) studied the effects of CAI on the locus of control of junior high school students. His hypothesis was based on findings of the Coleman Report (1966) which indicated that locus of control was highly correlated with achievement. The author reasoned that if school achievement was related to self-concept and locus of control, and if CAI increased achievement (as shown in previous research), then CAI should provide positive changes in self-concept and locus of control. Subjects were administered the Crandall Locus of Control Scale to assess a locus of control related specifically to mathematics, and the three locus of control items used in the Coleman study. Subjects were randomly assigned to either a CAI group or a non-CAI group. Results indicated no general increase in self-concept or locus of control for the CAI group.

It should be pointed out that high correlations between

locus of control and achievement do not necessarily imply a direct causal relationship. This study might have been improved by the use of an interaction model between a locus of control trait measurement and the treatment in use.

Crandall (1976), who hypothesized that student achievement increases with use of CAI because CAI allows the student to feel in control of his learning environment, drew students for his study from a grade school where CAI has been implemented in the past few years. By the end of the school year, subjects exhibited increases in achievement on standardized tests (in comparison with students of previous years) which Crandall attributed to a change in the students' locus of control. He based his assumption on arguments propounded by Vasquez (1974, cited in Crandall, 1976), who sought to increase understanding of perception of cause-and-effect relationships in the externally oriented child. In essence, Vasquez suggested that: (1) the cause should have sufficient power to produce the effect; (2) students should comprehend that without the cause, the action or result would not have occurred; (3) other equally likely causes must not be present if we are to identify a single cause; and (4) the cause must precede the event in time (Crandall, 1976, p. 3).

Crandall proposed that CAI satisfies these points in

that it has sufficient power, demonstrates cause-effect relationships within a short space of time, there is a direct relationship with the terminal, and that feedback is immediate. Whilst his study was more of a progress report, lacking experimental rigor, with no pre or posttest measures of locus of control, there is implied promise in his statements, when such pre and posttest measures of locus of control are properly obtained.

Summary and Implications for the Present Study

It is evident that although ATI research is still fraught with methodological problems, interactions between aptitudes and instructional treatments consistently appear in the literature. CAI provides an excellent medium for investigating learner by environment interactions. The ATI literature reports a considerable number of interaction effects between the degree of structure of the educational environment and various aptitudes. Locus of control appears frequently as one variable that interacts with degree of structure. Although inconsistent results in reported studies have been demonstrated, these may be due to either unsound methodology or to undetected higher-order interactions. Further research in this area should be guided by the objections raised above (see p.7) and with particular consideration given to the following three points:

1. Treatments should be of long duration and should utilize courses given in the actual instructional environment.

2. Measures of locus of control should be taken prior to treatment and during treatment, analogous to the "trait" and "state" anxiety model (cf. Spielberger, 1969).

3. Degree of structure of the treatments should be clearly defined.

As one such piece of further research it is proposed that full use be made of the computer as an instructional medium, that the treatments it presents shall vary in their degree of structure, and that objective measures, pre and posttest, be obtained of each student's perception of locus of control, hypothesized as a learner characteristic.

CHAPTER III

METHOD AND DESIGN

This study was conducted at McGill University, Montreal, Québec during the 1978-79 academic year.

Materials

The instructional materials used in this study consisted of the Interactive Computer Assisted Testing (ICAT) portion of the Introductory Educational Psychology course offered to students enrolled in the one year postbaccalaureate education program. Students were assigned to one of two sections, each taught by a different professor. Both sections were instructed by the traditional lecture method and utilized the same text.

Students were required to complete five ICAT quizzes during the academic year (28 weeks). Each quiz consisted of 20 multiple-choice questions randomly selected from a bank of approximately 130 questions per quiz. Therefore, selected questions varied from one presentation of a quiz to another. Questions were taken directly from the textbook (see Biehler, 1974). Grades on the quizzes comprised 30% of the total mark for the course. Each question was scored by a partial-scoring technique. Three marks were

given for the first correct attempt, 2 marks for the second, one mark for the third attempt and 0 on the fourth attempt. Criterion for a passing grade for each quiz was set at 80%. Students received immediate feedback as to whether or not their response was correct. In addition, feedback paragraphs could be requested which indicated the correct response and referred the student to a page in the textbook for further reference.

The courseware was written in CAN-VII (Cartwright and Quesnel, 1978) and implemented on IBM 370/158 under the MUSIC operating system. The courseware was distributed through ten Volker Craig CRT terminals.

Subjects

Fifty-five students enrolled in an educational psychology course initially participated in the study. Due to student attrition, the final sample consisted of 49 students, 9 males and 40 females. The average age was 25.3 with a range from 21.0 to 47.0 years of age.

Selection of Independent and Dependent Variables

Two learner characteristics were selected as independent variables: Internal-External Locus of Control, and A Control Assessment Questionnaire. The former was measured by the Internal-External Locus of Control Scale (Appendix A), developed by Rotter (1966) with reliability

and validity attested by Rotter (1966), Hersh (1967), Joe (1971) and factor analysis supplied by Joe and Jahn (1973). This questionnaire of 29 items, of which 6 are fillers, is presented as a six point Likkert scale imposed on a two choice dichotomy (see Appendix A), and is believed to yield measures on two major factors, the role of "fate or luck" in an individual's personal life, and the system of "social control." To ensure that measures of these two factors were elicited from the present sample, a factor analysis of the replies was undertaken, utilizing a principal component analysis followed by a Varimax rotation (Appendices E-I). Five minor factors were found to be present in a total of six items and these six items were subsequently removed. Hence locus of control scores for this experiment were based upon the responses to 23 items.

The individual's perception of the amount of control he believes he will possess when in a computer-assisted learning environment was measured by a ten item Control Questionnaire, derived from an attitude scale first used by Cranton (1976). As before, its applicability for the present sample was to be determined on the basis of analysis of inter-item correlations (Appendices J-L).[2]

Dependent variables were chosen from performance measures on the ICAT quizzes, and from the I-E scale. The performance measures selected were: (1) quiz averages;

(2) number of quizzes taken; and (3) modified gain scores (total time on-line was not recorded due to a programming error). Since treatments may affect learner characteristics, six items from the I-E scale were used as a measure of situation-specific locus of control or "state" locus of control, in a manner analogous to Spielberger's "trait" and "state" anxiety. These six items loaded heavily on elements of "fate" or "luck" in one's personal life established by Cranton (1976) and were administered at stated intervals during the treatments along with the Control Questionnaire.

An attitude posttest (Appendix D) was used to check students' perception of the structure of treatment groups against the experimental definition of the same treatments and was administered at the end of the 28 weeks.

Treatments

Students were randomly assigned to one of two treatment groups as they "signed-on" for their first quiz. Treatments differed in their degree of structure. In Group 1 (Practice and Tests) students were required to stipulate whether they wished to take a practice or a test run. Students were allowed a maximum of three test runs. The number of test runs had initially been set at two; however, due to extreme displeasure on the part of the students, it was changed to

a maximum of three. Students in this group had their grades recorded when they completed a test run. On test runs, students' scores were recorded automatically, any lower score being replaced by any subsequent higher score. In Group 2 (Trials Unlimited) students repeated each quiz as frequently as they wished. The students' scores for each quiz were recorded automatically, with any lower score being replaced by any subsequent higher score as in Group 1. The criterion set for a "pass" grade for each quiz was 80% for both treatment groups. The last recorded grade remained if the student did not attain the criterion score of 80%.

Procedure

All students were administered a paper and pencil pretest consisting of 50 multiple choice questions on the subject matter. Questions were taken directly from the textbook (see Biehler, 1974).[3] Each student was also administered the I-E scale and the Control Questionnaire (independent variables). Students were randomly assigned to one of two treatment groups. Upon completion of the first, third, and fifth quizzes (hereafter referred to as sessions A, B and C), students were tested on-line on two of the dependent variables: (1) the "state" I-E scale, and (2) the Control Questionnaire. Deadlines were set

for the completion of each quiz, so time intervals between the quizzes varied minimally from one student to the next.

At the end of the 28 weeks students were administered the attitude questionnaire to confirm the structure of the treatment groups, and to collect comments. A paper and pencil posttest on the subject matter (duplicate of pre-test) was administered as part of the final exam.

Hypotheses To Be Tested

These were of two kinds, null hypotheses and directional hypotheses, the former being tested by t-tests or chi-square, and the latter by a combination of regression analyses and t-tests.

The null hypotheses were:

1. Using average quiz score as dependent variable, there is no difference between treatment groups.

2. Using modified gain scores as dependent variable, there is no difference between treatment groups.

3. Using the number of quizzes taken as dependent variable, there is no difference between treatment groups.

4. There is no difference between treatment groups using I-E score as independent variable.

The directional hypotheses were:

5. The "state" I-E variables should differentially predict the "trait" I-E variable for each treatment group.

6. The independent variable I-E when matched with the congruent treatment (I - with low structure, E - with high structure) should be a better predictor of the dependent variable average quiz score, than when unmatched.

$H_o : B_1 = B_2$ $\qquad$ $H_1 : B_1 \neq B_2$

7. The independent variable I-E when matched with the congruent treatment (I - with low structure, E - with high structure) should be a better predictor of the dependent variable modified gain score, than when unmatched.

$H_o : B_1 = B_2$ $\qquad$ $H_1 : B_1 \neq B_2$

8. The I-E "state" variables should be better predictors of the dependent variable average quiz score, than the I-E "trait" variable.

CHAPTER IV

RESULTS

The study commenced with 55 subjects, but there was a loss due to academic attrition, of six subjects during the year. Faulty programming in the random number generator of the computer produced unequal numbers in the two treatment groups.

Table 1

Number of Students in Treatment Groups

	Group 1	Group 2	Total
All subjects	20	35	55
Subjects who completed study	16	33	49

Means and standard deviations of the dependent and independent variables are presented in Table 2. Correlations of dependent and independent variables are presented in Table 3.

Table 2

Means and Standard Deviations

Independent and Dependent Variables

	Group 1		Group 2		Total	
Variable	M	S.D.	M	S.D.	M	S.D.
I-E	54.80	7.25	58.36	10.19	57.20	9.41
Pret.	40.00	12.35	40.21	14.35	40.14	13.54
Postt.	71.50	11.14	71.76	9.78	71.67	10.13
MGainSc.	.53	.18	.53	.21	.53	.20
Qaver	88.64	4.11	87.59	5.15	87.94	4.82
FbTot	121.38	71.71	129.33	97.68	126.74	89.34
NoQTot	18.75	5.77	15.67	8.22	16.67	7.58
I-E (A)	16.81	5.74	17.36	6.50	17.18	6.21
(B)	15.75	4.58	14.76	6.53	16.08	5.93
(C)	15.25	3.51	12.70	7.57	13.53	6.60
	N = 16		N = 33		N = 49	

Legend (Tables 2 and 3)

I-E	Internal-External Locus of Control
Pret.	Pretest on subject matter
Postt.	Posttest on subject matter
MGainSc.	Modified gainscores
Qaver	Quiz Average - calculated on the basis of the final grades recorded for each quiz
FbTot	Number of feedback paragraphs requested by the students
NoQTot	Number of quizzes taken by the students
I-E (A)	Internal-External Locus of Control "state" measure
(B)	administered after quiz 1 (A), quiz 3 (B)
(C)	quiz 5 (C)

Table 3

Correlations Among Independent and Dependent Variables

	I-E	Pret	Postt	MGainSc	QAver	FbTot	NoQTot	I-E(A)	(B)
Pret	25								
Postt	-08	17							
MGainSc	-18	**-47	**72						
QAver	10	* 26	**43	* 26					
FbTot	-14	-10	-07	-00	-04				
NoQTot	-05	*-32	-12	07	08	**54			
I-E (A)	**49	04	04	06	00	10	02		
(B)	09	16	11	16	* 31	15	04	-04	
(C)	17	18	15	16	**41	14	01	-02	**64

* $p < .05$

** $p < .01$

Hypothesis 1

Using average quiz score as dependent variable, there is no difference between the treatment groups.

Table 4

t-test Between Groups on Quiz Average

Group	Mean	S.D.	t-Value	df.	2-Tail P.
1	88.64	4.11			
2	87.59	5.15	.71	47	.483

t = .71 is non-significant for 47 df.

The Null hypothesis is retained.

Hypothesis 2

Using modified gain scores as dependent variable, there is no difference between the treatment groups. Gain score = Posttest score - Pretest score. Modified gain score = Gain score/Perfect possible posttest score - Pretest score. Modified gain scores relate the actual gain from pretest to posttest to the maximum possible gain from pretest to posttest (cf. Tilton, 1949).

Table 5

t-test Between Groups on Modified Gain Scores

Group	Mean	t-Value	df.	2-Tail P.
1	.528			
2	.533	-0.08	47	.934

t = -0.08 is non-significant for 47 df.

The Null hypothesis is retained.

Hypothesis 3

Using the number of quizzes taken as dependent variable, there is no difference between the treatment groups.

Table 6

Chi-square Between Groups on

Number of Quizzes Taken

Group	Mean	Chi-square	df.	Prob.
1	18.75			
2	15.61	30.05	22	.117

Chi-square = 30.05 is non-significant for 22 df.

The Null hypothesis is retained.

Hypothesis 4

There is no difference between treatment groups using I-E scores as independent variable.

Table 7

t-test Between Groups on I-E Scores

Group	Mean	S.D.	t-Value	df.	2-Tail P.
1	54.80	7.25			
2	58.35	10.19	-1.21	47	.234

t = -1.21 is non significant for 47 df.

The Null hypothesis is retained.

Hypothesis 5

The "state" I-E variables should differentially predict the "trait" I-E variable, for each treatment group.

A regression analysis was performed employing the extra sum of squares principle (cf. Draper & Smith, 1966). Separate equations were fitted for each group, then one equation for the total sample. The extra variance accounted for by the separate equations was examined. Table 8 presents the results.

Table 8

Test for Differential Prediction Using the

Extra Sums of Squares Principle

I-E "State"

1. Fit separate slopes:

	Sums of Squares			
Group	Total	R	Adj.	df.
1	736.40	277.69	458.71	11
2	3117.10	872.59	2244.51	27
	3853.50	1150.28	2703.22	38

2. Fit one slope:

2981.24	1074.02	2907.22	42

3. EXSS = SSADJ.2 - SSADJ.1

2907.22 - 2703.22 = 204.0

DF = 42 - 38 = 4

F = (204.0/4) / (2703.22/38) = 51 / 71.14 = .716

F = .716 F critical (p = .05) = 2.62

F = .716 is non significant for df. (4, 38).

The hypothesis is rejected.

Hypothesis 6

The independent variable I-E when matched with the congruent treatment (I - with low structure, E - with high structure) should be a better predictor of the dependent variable average quiz score, than when unmatched.

A regression analysis was performed and t-tests for the following:

$H_o : \beta_1 = 0$ $\quad$ $H_1 : \beta_1 \neq 0$

$H_o : \beta_2 = 0$ $\quad$ $H_1 : \beta_2 \neq 0$

If $\beta_1 \neq 0$ and $\beta_2 \neq 0$

then $H_o : \beta_1 = \beta_2$ $\quad$ $H_1 : \beta_1 \neq \beta_2$ is tested.

Table 9 presents the results.

The Null hypothesis $H_o : \beta_1 = 0$, $H_o : \beta_2 = 0$ is retained. Subsequent comparisons between the slopes were therefore not performed.

Table 9

t-tests on Slopes of the Regression Equations

Group	Quiz Average
Unmatched	$H_o : \beta_1 = 0$ $H_1 : \beta_1 \neq 0$
	$b_I = -.154$ 2.074 (.083)
	$t = b_1 / s.e.\ (b_1)$
	$t = -1.86$ t critical ($p = .05$) = 2.074
	therefore $b_1 = 0$
Matched	$H_o : \beta_2 = 0$ $H_1 : \beta_2 \neq 0$
	$b_2 = .138$ 2.086 (.155)
	$t = b_2 / s.e.\ (b_2)$
	$t = .890$ t critical ($p = .05$) = 2.086
	therefore $b_2 = 0$

Legend (Tables 9 and 10)

Unmatched: I - with high structure (Practice and Tests)
E - with low structure (Trials Unlimited)

Matched: I - with low structure (Trials Unlimited)
E - with high structure (Practice and Tests)

Hypothesis 7

The independent variable I-E when matched with the congruent treatment (I - with low structure, E - with high structure) should be a better predictor of the dependent variable modified gain score, than when unmatched.

A regression analysis was performed and t-tests for the following:

$H_o : \beta_1 = 0$ $\quad H_1 : \beta_1 \neq 0$

$H_o : \beta_2 = 0$ $\quad H_1 : \beta_2 \neq 0$

If $\beta_1 \neq 0$ and $\beta_2 \neq 0$

then $H_o : \beta_1 = \beta_2$ $\quad H_1 : \beta_1 \neq \beta_2$ is tested.

Table 10 presents the results.

The Null hypothesis $H_o : \beta_1 = 0$, $H_o : \beta_2 = 0$ is rejected. Subsequent comparison between the slopes yields $\beta_1 \neq \beta_2$. Therefore the Null hypothesis $H_o : \beta_1 = \beta_2$ is rejected. The independent variable I-E when matched with the congruent treatment is a better predictor of the dependent variable, modified gain score.

Table 10

t-tests on Slopes and Comparison

of the Regression Equations

Group	Modified Gain Score
Unmatched	$H_o : \beta_1 = 0$ $H_1 : \beta_1 \neq 0$
	$b_1 = -.071$ 2.074 (.005)
	$t = b_1 / \text{s.e.}(b_1)$
	$t = -14.2$ t critical ($p = .05$) = 2.074
	therefore $b_1 \neq 0$
	$-.081 \leq b_1 \leq .061$
Matched	$H_o : \beta_2 = 0$ $H_1 : \beta_2 \neq 0$
	$b_2 = -.410$ 2.086 (.005)
	$t = b_2 / \text{s.c.}(b_2)$
	$t = -82.0$ t critical ($p = .05$) = 2.086
	therefore $b_2 \neq 0$
	$b_1 \neq b_2$

Hypothesis 8

The I-E "state" variables should be better predictors of the dependent variable average quiz score, than the I-E "trait" variable.

A stepwise regression analysis was performed. Order of inclusion of the variables was not stipulated. The program automatically entered the variables in single steps starting with that which accounted for the greatest amount of the variance, then that which explained the greatest amount of the variance in conjunction with the first variable, and so on. Table 11 presents the results.

Results indicate that I-E "state" (C) and I-E "state" (B) account jointly for 15.3% of the variance. Addition of the I-E "trait" variable accounts for 15.4% of the variance while further inclusion of the I-E "state" (A) accounts for 15.5% of the variance. The hypothesis is therefore not rejected. I-E "state" (C) and (B) are better predictors of the dependent variable quiz average than I-E "trait."

Table 11

Stepwise Regression Analysis

Quiz Average

Source	DF	Sum of Squares	R Square	F
I-E State (C)	1	152.91	.148	**7.67
	44	876.83		
I-E State (B)	2	158.31	.153	*3.91
	43	871.43		
I-E Trait	3	159.55	.154	2.57
	42	870.182		
I-E State (A)	4	160.23	.155	1.89
	41	869.51		

* $p < .05$

** $p < .01$

Additional Analyses

The major hypotheses having been tested, supplementary analyses were performed in the light of the results obtained. The following questions were posed: (1) Are there any overall changes in I-E "state" and if so, in what direction? (2) Is there any difference in change of I-E scores between subjects labelled as Internals and those labelled as Externals by virtue of presumed locus of control?

1. A t-test statistic was computed comparing the pre-treatment or "trait" I-E scores and the post-treatment or final "state" I-E score.

Table 12

t-test Between Pre- and Post-Treatment I-E Measures

Mean Difference	S.D.	t-Value	df.	2-Tail P.
5.43	7.34	5.02	45	.000

t = 5.02 is significant for 45 df.

A significant overall change towards internality was found.

2. A t-test was then performed to test if the mean amount of change for the Internals differed from the mean amount of change for the Externals.

Table 13

t-test Between Internals and Externals on Pre- and Post-Treatment I-E Measures

Group	Mean Difference	S.D.	t-Value	df.	2-Tail P.
Internals	2.56	5.91			
Externals	9.53	7.36	3.56	44	.001

t = 3.56 is significant for 44 df.

A significant difference between the amount of change in I-E scores exists between the Internals and Externals. Externals exhibited a significantly greater amount of change towards internality than did Internals.

Further analyses are presented in the form of supplementary tables. Discussion of these tables is to be found in Chapter V, Discussion of Results.

Supplementary Tables

Table 14

Chi-square Between Groups on Number of Feedback Paragraphs Requested

Group	Mean	Chi-square	df.	Prob.
1	121.38			
2	129.33	48.99	46	p = .35

Chi-square = 48.99 is non significant for 46 df.

Table 15

Frequencies of Responses:

Attitude Questionnaire

	Frequencies			
Item	1	2	3	Missing
1	16	33	-	-
2	26	19	-	4
3	8	34	-	7
4	21	21	-	7
5	35	10	-	4
6	16	13	16	4
7	20	10	1	18

Table 16

Frequencies of Responses: Comparison of Perceived Structure of Treatment Groups

Grp. perceived as more structured	N	Relative frequency (percent)	Adjusted frequency (percent)
Grp. 1	26	61	58
Grp. 2	19	31	42
Missing	4	8	-
	49	100	100

Table 17

Frequencies of Responses: Comparison of Perceived Structure of Treatment Groups by Group

Group Membership	Group perceived as More Structured		Missing
	Grp. 1	Grp. 2	
1	12	4	
2	14	15	4
	26	19	4

Table 18

Frequencies of Responses: Perceived Structure of Treatment Groups

	N	Relative frequency (percent)	Adjusted frequency (percent)
Very structured	35	71	78
Not very structured	10	21	22
Missing	4	8	-
	49	100	100

Table 19

Frequencies of Responses: Perceived Structure of Treatment Groups by Group

Group	Very Structured	Not Very Structured	Missing
1	14	2	-
2	21	8	4
	35	10	4

Table 20

Frequencies of Responses: Preference for Treatment

Preferred Grp.	N	Relative frequency (percent)	Adjusted frequency (percent)
Grp. 1	8	16	19
Grp. 2	34	69	81
Missing	7	15	-
	49	100	100

Table 21

Frequencies of Responses: Preference for Treatment by Group

Group	Preferred Group		Missing
	Grp. 1	Grp. 2	
1	8	6	2
2	0	28	5
	8	34	7

CHAPTER V

DISCUSSION OF RESULTS AND IMPLICATIONS OF THE STUDY

The purpose of the study was to investigate the effects of two modes of presentation of a computer assisted environment on students' performance and their perceived locus of control. Interaction effects were hypothesized, however the results indicated that no clear interactions were present and unpredicted findings were noted. Discussion of the results as well as the theoretical and the practical implications of the study follow.

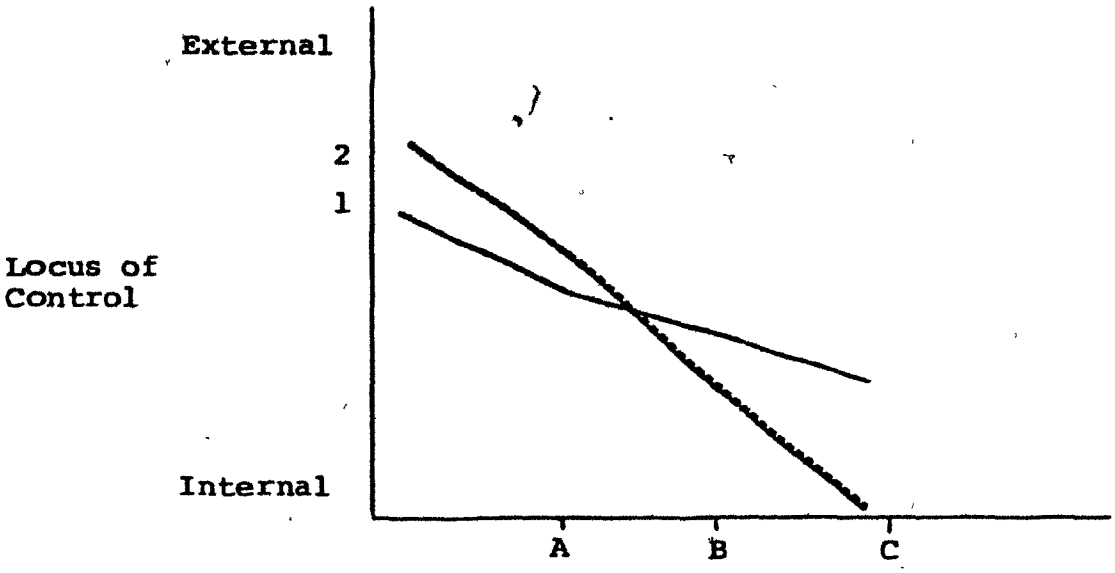
As hypothesized, no difference was found between the treatment groups on the amount of material the students learned. This was ascertained by examination of the quiz averages and the modified gain scores. Both treatment groups completed approximately the same number of quizzes and the average of the I-E scores for each group did not differ significantly.

In addition, the number of feedback paragraphs requested by the students was examined. This procedure was carried out to determine whether or not the amount of material presented during the quizzes was equal for both

groups. The results (see Table 14) indicate that the groups did not differ on the number of feedback paragraphs requested. Now if the number of feedback paragraphs requested had differed for the two groups, one could have argued that the learning environment was substantially different by one group utilizing the quizzes more as a method of learning rather than an evaluative technique and any differences between groups on quiz average or modified gain score could have been accounted for by the difference in the exposure of material. Since this was not the case, it can be assumed that each group was presented an equal amount of material on-line and that the environment was both a learning and an evaluative experience for both groups.

Contrary to what was hypothesized, knowledge of group membership and the students' scores on the "state" I-E variables did not predict their "trait" I-E scores. In other words, there was no significant interaction between the treatment group and the students' "trait" I-E. Although no interaction was present, there was a tendency to a slight disordinal interaction. Figure 1 illustrates the regression lines and the crossover.

This tendency is more obvious in diagram 2 (Figure 1) where separate regression lines are drawn for the Internals and the Externals in each treatment group. This trend may indicate that there would be a significant interaction with



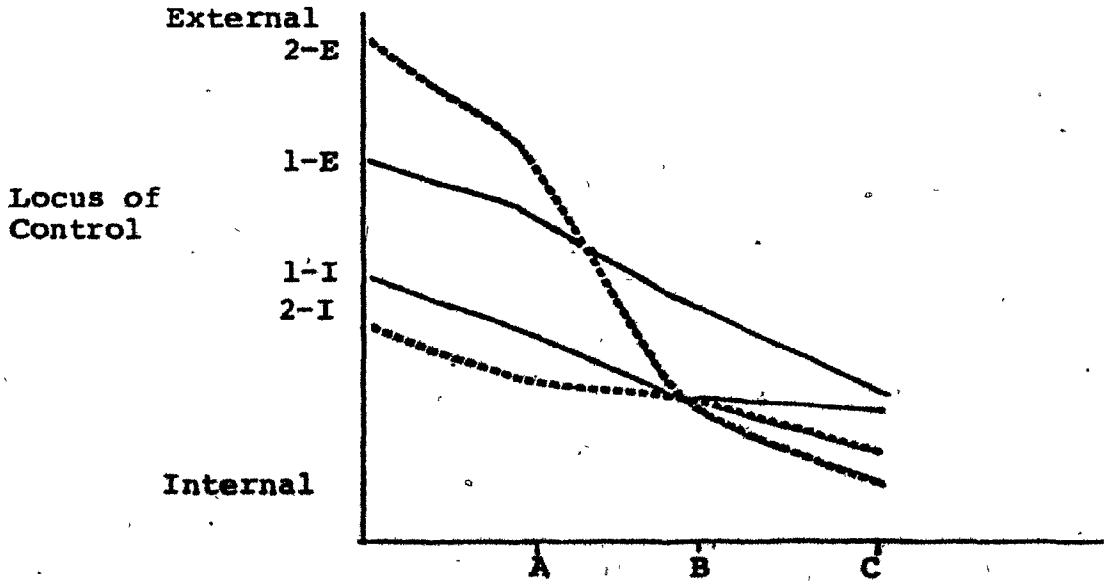
- 1 -

1 = Group 1 (Practice and Tests)

2 = Group 2 (Trials Unlimited)

I = Internal subjects, E = External subjects

A, B; C = Measurement intervals



- 2 -

Figure 1: Graphs of the I-E "State" Variables

a less homogeneous population and with treatments that clearly vary (to be discussed below). The spread of I-E scores for university and college populations is generally small, as is that of the present sample. Interaction effects therefore, may have been inhibited by the limited scope of the personality trait represented in the sample.

The examination of additional data suggests other possible explanations for the lack of an interaction. Results of the attitude questionnaire (see Table 16) indicate that subjects did not perceive clear differences between the structure of the treatment groups: 42% of those students who responded did not perceive the "Practice and Tests" (Group 1) as more structured than the "Trials Unlimited" (Group 2). However, in Group 1, the majority of students perceived that treatment as having more structure whereas in Group 2, only half of the students perceived the "Practice and Tests" (Group 1) as more structured (see Table 17). In addition, 78% of those subjects who responded felt that the condition they were assigned to (regardless of treatment group) was very structured (see Table 18).

The students' perceptions of the structure of the treatments may be due to the fact that the quizzes were required course work and regardless of their mode of

presentation, would be viewed as imposed structure. Also, there may be a general tendency for students to view any program produced by computers as being structured. Such was the finding of Cranton's study (1976) where subjects commented on the narrowness of the computer and its inability to comprehend alternate wording. In addition, students may not have been familiar with the conditions of the other treatment and therefore had no basis for comparison.

An additional analysis found that 81% of all subjects who responded stated that they preferred or would have preferred assignment to the "Trials Unlimited" group (Group 2) (see Table 20). Of those subjects in Group 2 who responded, all stated their preferred treatment to be the group they were assigned (see Table 21). The students' preference for this condition may have been based on their perceptions of the structure. At the beginning of the year, students expressed very negative feelings about the number of tests they were allowed to take, subsequently, the number was changed from two to three. The students originally thought that the "Practice and Tests" (Group 1) condition would require that they take the quizzes more often, first to practice, then as a test. In fact, there was no difference between the means of the

groups on the number of quizzes taken (see Table 2). Students in the "Practice and Tests" (Group 1) may have come to realize this whereas those in the "Trials Unlimited" (Group 2) may not have. Therefore students in Group 2 may have preferred their own condition for this reason.

Although the students did not perceive the degree of structure of the treatments in the manner in which they were designed, in general they preferred the less structured treatment. It is possible that requesting students to classify treatments in terms of structure is an ambiguous task and invites bias as to preference for treatment rather than objective classification.

The failure to clearly confirm the structure of the treatment groups leads to inconclusive results and illustrates the necessity of establishing treatments which are perceived as significantly different. A similar problem was encountered by Cranton (1976), where students did not perceive differences between groups on the degree of learner control. Tobias and Duchastel (1973) experienced the same difficulty. Subjects in their study did not appear to utilize the behavioral objectives provided, which were an essential part of the treatments, thus rendering the treatments virtually equal. The authors concluded that no interaction was present due to the lack of perceived differences between the treatment groups.

It was possible to consider cases where treatment and personality trait were congruent. The performance of such individuals could then be examined and an attempt made to replicate previously reported interaction effects when I-E scores were matched to the degree of structure of the treatments (Internals with low structure, Externals with high structure). Studies by Cranton (1979), Parent et al. (1975), and Daniels and Stevens (1976) reported better prediction and higher achievement scores when the learner characteristic I-E was matched with the appropriate treatment.

In the present study, the amount of variance accounted for by matching the treatments and I-E scores in predicting quiz averages was not significant, and was likely due to the 80% criterion set for each quiz which resulted in little variation among the quiz averages. Therefore comparison between the treatments was not attempted.

When modified gain scores were predicted using the matched and unmatched groups, those groups in which I-E "trait" was matched with the treatment (Internals with Group 1 and Externals with Group 2) were better predictors of the gain scores than those groups in which I-E "trait" was not matched with the treatment. This finding does not necessarily contradict the nonsignificant prediction of the quiz averages when the treatments and I-E scores

were matched. The variance of the modified gain scores was greater than the variance of the quiz averages and therefore might have been able to reflect the matching of the learner characteristic with the appropriate treatment. These results must be regarded with some caution due to the inherent weakness of gain scores especially as gain scores were calculated on the basis of paper and pencil pretests and posttests. Reflection in the gain scores of effects from the match of trait and treatment on-line thus involves a transfer effect to the non-computer environment.

The I-E "state" variables were found to be better predictors of the average quiz score than the "trait" I-E variable. The second and third measurements of I-E "state" (C & B) accounted for 15.3% of the variance while the inclusion of I-E "trait" in the equation accounted for only an additional .1%. This is not surprising due to the above stated findings which indicated that I-E "trait" was related to performance (gain scores) only when matched with the appropriate treatment and unrelated when unmatched. Of note is that the "state" I-E scores were able to predict quiz averages even though variation among these averages was limited due to the 80% criterion set. It is likely therefore that I-E "trait," when matched with the appropriate treatment, is unable to predict the

quiz averages due to its lack of relationship rather than due to the small variation among the quiz averages. The correlation between "trait" I-E and quiz average substantiates this claim. In addition, the correlations between quiz average and I-E "state" B, and I-E "state" C indicate that as time goes by, the state measures change, relating to the achievement and not relating to the original personality measure (see Table 3).

These results agree with the Spielberger model where "A-state" (situational anxiety) is generally a better predictor of achievement than "A-trait" (trait anxiety). These findings lend support also to Cronbach and Snow's (1977) stance that learner characteristics should be reassessed throughout the treatment because they may be effected by the treatment. In this manner, independent variables become dependent variables as well.

The additional analyses indicated that there was a significant overall change in I-E "state" scores towards internality. These results were quite unexpected and merit further discussion.

Subjects, regardless of their treatment group, exhibited more Internal scores at the end of the treatment than at the beginning. The most noticeable changes occurred in the B and C sessions where the correlations with I-E "trait" became extremely weak (see Table 3).

It will be noted further that the External subjects exhibited significantly greater change towards internality than did the Internal subjects. These results were surprising since the instructional medium, the computer, appeared to elicit a greater change in the External subjects than the Internal subjects regardless of the amount of structure of the treatment groups.

These results are contrary to Smith's (1974) findings. In his study no overall change in I-E scores was exhibited by the CAI group as opposed to the non-CAI group. However, his post-treatment I-E measure was not taken during the instructional treatment but rather after treatment and therefore was less likely to be situation-specific. It is highly probable that I-E scores might be affected by the treatment during the treatment, but they may not generalize to feelings of control outside the instructional setting.

The results of the present study also lend support to Crandall's (1976) hypothesis, which is based on four points deemed necessary to increase the understanding of cause-effect relationships in the externally controlled individual (refer to p. 33). Crandall feels that CAI fulfills these prerequisites and thus acts as a change agent, eliciting perceptions of internal feelings of

control over one's environment.

It is essential, however, to consider other viable alternatives which may have contributed to this change. Familiarity with the format and content of the questionnaire, which was repeated three times throughout the course of the study, may have artificially created a feeling of control. However, usually repetition of items yields highly correlated results (as in test-retest reliability). Additionally, increased familiarity with the computer and the technical aspects entailed would contribute to feelings of mastery and control. These feelings may transfer to more general feelings of mastery of the environment.

The above stated reasons, however, do not appear to be sufficient to account for a significant difference in the change of I-E scores between the Internals and the Externals. If feelings of control were artificially elicited, one would not have expected a better prediction of performance (quiz average) from the I-E "state" variables than from the I+E "trait" variable.

An additional factor that must be considered is the weakness of gain scores. Obviously there is a ceiling effect on the amount of internality one can feel. It is noticeable that the endpoints, at "state" C, are at relatively the same position for both the Internal subjects

and the External subjects (see Figure 1).

Limitations of the Study

The present study, like many others, has limitations. In the first place, students in Group 1 were initially unhappy about the number of test runs they were allowed to take and subsequently the number was increased from two to three. Their dissatisfaction at the outset may have influenced their perception of the amount of control or lack of control they had over their learning environment.

Change of computer language from CAN-VI to CAN-VII, imposed from the Computing Centre, caused program errors which had to be ironed out in the first few weeks of the study. Such errors, not correctable by the students themselves, may have caused frustration and influenced their perceptions of control over the environment. Results of the attitude questionnaire (see Table 15) indicate such errors were encountered.

The failure to confirm the structure of the treatment groups confounds the results. It becomes difficult to determine why no significant interaction effects were found between the treatments and the students' personality trait. It may be due either to (1) no interaction effects, or (2) no actual differences between the perceived structure

of the groups, thus eradicating the treatment effects and consequently the interactions.

The factor structure of the I-E scale for the present sample did not correspond exactly to the previously established factor structure. Items were discarded subsequently, and may have affected the validity of the measure.

The questionnaire on perceived control in the computer environment was not utilized because of its lack of validity. A valid measure of this kind, had it been available, would have added valuable information on the students' perception of computer-assisted instruction and their feelings about the amount of structure imposed upon them by the computer as a medium of instruction.

Practical Implications

The findings of this study lend support to Crandall's (1976) hypothesis that CAI acts as a catalyst in bringing about change in students' perceived locus of control.

In practice, CAI could be used in situations where students feel they have little control over the subject matter or are inhibited about learning due to their perceptions of having little control over their environment. The use of CAI in the remediation of learning difficulties may prove valuable in that the students would have the opportunity to acquire a sense of control and mastery

over their environment. Although locus of control has not been established as a causal factor in students' achievement, there is a consistent belief that there is a relationship between the two (cf. Coleman, 1966). Increasing feelings of internality may contribute to positive feelings about the subject matter, thus encouraging continuation on task and contributing to an increase in achievement.

Theoretical Implications

The results of the present study support the use of locus of control as a relevant learner characteristic in a computer assisted instructional environment.

Of importance is the finding that locus of control, postulated by Rotter (1966) as a stable personality dimension, noticeably changed throughout the course of the study. Subjects in both treatment groups exhibited a change towards internality. In the light of these results, the validity of measuring locus of control and other personality measures as strictly trait dimensions must be questioned. It is possible that many personality variables would exhibit a similar pattern in that the individual might have a predisposition for a particular trait which is subsequently affected in various ways by the situation that he is put in. In other words, use of Spielberger's "trait" and "state" model in the measurement of personality may provide

invaluable information and insight into the dynamics of interactions between the students' personality and the instructional medium and/or methodology utilized.

This study also suggests that computer assisted instruction may have considerable effects on the learner regardless of differences in the modes of presentation employed (treatments). It becomes apparent that the computer assisted environment is quite unique and warrants further investigation.

Suggestions for Further Research

The findings of this study indicate that locus of control appears to interact with the instructional medium, but not with the mode of presentation. Suggestions for further research are listed below.

1. Refinement and validation of a shortened version of the I-E scale should be carried out so that "state" I-E is measured in a valid and reliable manner.

2. Validation of treatment groups should be established prior to the study. Students could be asked to rank order types of instruction and/or modes of presentation by their degree of structure.

3. Various personality dimensions could be measured prior to, and during treatment to investigate whether or not they are influenced by situational factors as was

locus of control. In addition, several age groups could be utilized to see if similar effects are exhibited between the groups.

4. Continued use of long-range instructional treatment such as that in the present study, which was of a 28 week duration, should be encouraged. Long-range studies allow sufficient time for changes to occur in the variables measured and also illustrate the pattern of these changes.

Conclusion

The results of the study indicate that there was no interaction effect between the treatment groups and the learner characteristic of locus of control. The structure of the treatment groups was not clearly validated, thus causing some ambiguity as to whether interactions were not apparent because: (1) students saw no difference in structure between the treatment groups, or because (2) locus of control does not actually interact with degree of structure in a CAI setting. Another possibility is that use of the computer may cause stronger overall effects which have a tendency to conceal those of the treatment conditions. This appears to be the case in the present study. Students did not clearly perceive the differences in treatment groups and main effects were found. Overall changes in locus of control scores towards the internal

pole were noted. In addition, the External subjects exhibited significantly greater changes in I-E scores than did the Internal subjects.

Reference Notes

[1]Locus of control (Rotter, 1966) is a dimension which measures an individual's perception of the amount of control he has over his environment.

[2]On the basis of these analyses, this scale was rejected, and reliance placed on the Internal-External Locus of Control Scale.

[3]A copy of this test is not included because it is currently being used as the pre and posttest measure for a course at McGill University, but a copy is retained on file at the Department of Educational Psychology and Sociology, McGill University.

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APPENDIX A

I-E Scale: "Trait"

The following questionnaire is given to find out how important events in our society affect different people. Each item consists of a pair of alternatives lettered A or B. Please select the statement of each pair which you more strongly <u>believe</u> to be the case as far as you're concerned. Show the amount of your agreement by circling a number from 1 to 6. The number 1 shows strong agreement with statement A and the number 6 shows strong agreement with statement B. Be sure to select that which you actually <u>believe</u> to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously there are no right or wrong answers.

Please answer these items <u>carefully</u> but do not spend too much time on any one item. Be sure to find an answer for <u>every</u> choice.

Be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item <u>independently</u> when making your choice; do not be influenced by your previous choice.

Example:

Statement A		Statement B
I enjoy listening to records.	1 2 3 4 5 6	I don't like listening to records.

In this example the number 3 has been chosen. This means that the person enjoys listening to records, but does not feel very strongly about it. If he felt more strongly about it, he would have circled number 1 or 2.

Statement A		Statement B
1. Children get into trouble because their parents punish them too much.	1 2 3 4 5 6	The trouble with most children nowadays is that their parents are too easy with them.
2. Many of the unhappy things in people's lives are partly due to bad luck.	1 2 3 4 5 6	Peoples' misfortunes result from the mistakes they make.
3. One of the major reasons why we have wars is because people don't take enough interest in politics.	1 2 3 4 5 6	There will always be wars, no matter how hard people try to prevent them.
4. In the long run people get the respect they deserve in this world.	1 2 3 4 5 6	Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.
5. The idea that teachers are unfair to students is nonsense.	1 2 3 4 5 6	Most students don't realize the extent to which their grades are influenced by accidental happenings.
6. Without the right breaks one cannot be an effective leader.	1 2 3 4 5 6	Capable people who fail to become leaders have not taken advantage of their opportunities.
7. No matter how hard you try some people just don't like you.	1 2 3 4 5 6	People who can't get others to like them don't understand how to get along with others.

8.	Heredity plays the major role in determining one's personality.	1 2 3 4 5 6	It is one's experiences in life which determine what they're like.
9.	I have often found that what is going to happen will happen.	1 2 3 4 5 6	Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.
10.	In the case of the well prepared student there is rarely if ever such a thing as an unfair test.	1 2 3 4 5 6	Many times exam questions tend to be so unrelated to course work that studying is really useless.
11.	Becoming a success is a matter of hard work, luck has little or nothing to do with it.	1 2 3 4 5 6	Getting a good job depends mainly on being in the right place at the right time.
12.	The average citizen can have an influence in government decisions.	1 2 3 4 5 6	This world is run by the few people in power, and there is not much the little guy can do about it.
13.	When I make plans, I am almost certain that I can make them work.	1 2 3 4 5 6	It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune tomorrow.
14.	There are some people who are just no good.	1 2 3 4 5 6	There is some good in everybody.
15.	In my case getting what I want has little or nothing to do with luck.	1 2 3 4 5 6	Many times we might just as well decide what to do by flipping a coin.
16.	Who gets to be the boss often depends on who was lucky enough to be in the right place first.	1 2 3 4 5 6	Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.
17.	As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.	1 2 3 4 5 6	By taking an active part in political and social affairs the people can control world events.

18.	Most people don't realize the extent to which their lives are controlled by accidental happenings.	1 2 3 4 5 6	There really is no such thing as "luck."
19.	One should always be willing to admit mistakes.	1 2 3 4 5 6	It is usually best to cover up one's mistakes.
20.	It is hard to know whether or not a person really likes you.	1 2 3 4 5 6	How many friends you have depends upon how nice a person you are.
21.	In the long run the bad things that happen to us are balanced by the good ones.	1 2 3 4 5 6	Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.
22.	With enough effort we can wipe out political corruption.	1 2 3 4 5 6	It is difficult for people to have much control over the things that politicians do in office.
23.	Sometimes I can't understand how teachers arrive at the grades they do.	1 2 3 4 5 6	There is a direct connection between how hard I study and the grades I get.
24.	A good leader expects people to decide for themselves what they should do.	1 2 3 4 5 6	A good leader makes it clear to everybody what their jobs are.
25.	Many times I feel that I have little influence over the things that happen to me.	1 2 3 4 5 6	It is impossible for me to believe that chance or luck plays an important part in my life.
26.	People are lonely because they don't try to be friendly.	1 2 3 4 5 6	There's not much use in trying too hard to please people, if they like you, they like you.
27.	There is too much emphasis on athletics in high school.	1 2 3 4 5 6	Team sports are an excellent way to build character.
28.	What happens to me is my own doing.	1 2 3 4 5 6	Sometimes I feel that I don't have enough control over the direction my life is taking.

29. Most of the time I can't understand why politicians behave the way they do.	1 2 3 4 5 6	In the long run the people are responsible for bad government on a national as well as on a local level.

APPENDIX B

Control Questionnaire

Have you ever taken a computer assisted instruction course before?

yes no

Please circle one of the numbers 1 to 5 to show how much you agree with the following statements.

1. Using the computer (in this course) will meet the needs of the individual student.	strongly agree	1 2 3 4 5 strongly disagree
2. I feel I would have more control over what I learn if I was dealing with a person rather than a machine.	strongly agree	1 2 3 4 5 strongly disagree
3. Computer assisted instruction will provide a fair way of dealing with all students (i.e. treat everybody equal).	strongly agree	1 2 3 4 5 strongly disagree
4. The computer program is already written and decided upon for students. He has no say in how he is to be taught.	strongly agree	1 2 3 4 5 strongly disagree
5. Computer assisted instruction will control how the student is to learn the material in the course.	strongly agree	1 2 3 4 5 strongly disagree
6. One cannot argue with a computer therefore computer instruction will not be a fair way of dealing with all students.	strongly agree	1 2 3 4 5 strongly disagree
7. I feel that I will have control over what I learn from the computer.	strongly agree	1 2 3 4 5 strongly disagree

8.	The student can ask the professor to change his/her method of teaching but must "like or lump" the way the computer is teaching him.	strongly agree	1	2	3	4	5	strongly disagree
9.	I feel I would have more control of my marks if I were graded by computer rather than by the professor.	strongly agree	1	2	3	4	5	strongly disagree
10.	If the student does not like the way the computer is teaching him, he can change the methods of presentation to suit himself.	strongly agree	1	2	3	4	5	strongly disagree

APPENDIX C

I-E Scale: "State"

We are interested in looking into the relationship between peoples' feelings on certain issues and the way in which they learn, using the computer. A list of questions will follow which should take approximately 10 minutes to answer. You will be asked questions two other times throughout the school year (between now and April). We are interested in your responses over this period of time. Answer the questions by how you are feeling at this moment. Your time and cooperation is greatly appreciated, for it will help us to plan computer assisted instruction in the future.

The following questionnaire is to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered A or B. Please select the statement of each pair which you more strongly feel (at this moment) to be the case as far as you're concerned. Show the amount of your agreement by choosing a number from 1 to 6. The number 1 shows strong agreement with statement A, and the number 6 shows strong agreement with statement B.

Be sure to select that which you actually feel to be more true, rather than the one you would like to be true.

This is a measure of personal belief; there are no right or wrong answers.

Example:

Statement A		Statement B
I enjoy listening to records.	1 2 3 4 5 6	I don't like listening to records.

In this example, the number 3 has been chosen. This means that the person enjoys listening to records, but does not feel strongly about it. If he felt more strongly about it, he would have chosen number 1 or 2.

Statement A		Statement B
1. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.	1 2 3 4 5 6	Many times exam questions tend to be so unrelated to course work that studying is really useless.
2. Becoming a success is a matter of hard work, luck has little to do with it.	1 2 3 4 5 6	Getting a good job depends mainly on being in the right place at the right time.
3. When I make plans, I am almost certain that I can make them work.	1 2 3 4 5 6	It's not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune tomorrow.
4. Who gets to be the boss often depends on who was lucky enough to be in the right place first.	1 2 3 4 5 6	Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

*5. Most people don't realize the extent to which their lives are controlled by accidental happenings.	1 2 3 4 5 6	There is really no such thing as "luck."
6. Sometimes I can't understand how teachers arrive at the grades they do.	1 2 3 4 5 6	There is a direct connection between how hard I study and the grades I get.
7. What happens to me is my own doing.	1 2 3 4 5 6	Sometimes I feel that I don't have enough control over the direction my life is taking.

* Item removed.

( )

APPENDIX D

Attitude Questionnaire

1. Please circle the condition you were assigned to:

   1. Practice and then test (3 only)
   2. Repeat quiz as many times as necessary to attain 80%.

2. Which of the two conditions do you feel is more structured?

   1. or 2.

3. Would you prefer to have been assigned to the other condition? Yes or No

4. Did you feel the computer quizzes were a means of learning the material or of testing you on the material?

   1. Learning or 2. Testing

5. Did you feel that the condition you were assigned to was very structured? Yes or No

6. Did you encounter any difficulties in using the computer?

   1. No.
   2. Yes - difficulties in signing-on, signing-off, using the message facility, asking for feedback paragraphs, etc.
   3. Yes - "run aborted," program errors, power going off, etc.

7. If yes to above question, approximately how many times did you encounter these difficulties?

   1. 1-4 times
   2. 5-8 times
   3. 8 or more times

COMMENTS:

THANK YOU FOR YOUR COOPERATION

APPENDIX E

Frequencies of Responses for Each Item on the I-E Scale

Item	1	2	3	4	5	6	Missing
*1	0	4	14	19	10	1	0
2	4	11	12	15	5	1	0
3	1	3	13	16	6	9	0
4	0	7	10	12	11	8	0
5	5	6	16	12	4	5	0
6	6	14	12	12	3	1	0
7	2	10	8	9	10	9	0
*8	1	1	1	14	17	14	0
9	10	12	7	8	6	5	0
10	2	15	15	11	3	2	0
11	2	6	8	18	6	8	0
12	5	8	9	9	9	8	0
13	8	12	6	9	9	4	0
*14	3	2	4	4	10	25	0
15	7	10	17	6	6	2	0
16	7	11	13	9	7	1	0
17	3	11	16	7	6	5	0
18	4	2	12	20	5	5	0
*19	31	11	3	2	1	0	0
20	5	8	15	11	6	3	0
21	4	3	8	11	15	7	0
22	4	6	9	15	5	9	0
23	4	19	11	8	4	2	0
*24	4	6	10	9	11	8	0
25	2	5	14	17	7	3	0
26	5	6	15	16	3	3	0
*27	0	2	6	10	22	8	0
28	7	20	8	8	5	0	0
29	6	7	14	15	5	1	0

*Filler items

APPENDIX F

Means and Standard Deviations Per Item on the I-E Scale

Item	Mean	Standard Deviation
*1	3.79	.94
2	3.19	1.21
3	4.04	1.27
4	4.06	1.31
5	3.39	1.39
6	2.89	1.23
7	3.88	1.54
*8	4.81	1.08
9	3.06	1.65
10	3.08	1.16
11	3.92	1.36
12	3.69	1.61
13	3.23	1.61
*14	4.90	1.53
15	3.00	1.35
16	3.02	1.34
17	3.35	1.41
18	3.73	1.28
*19	1.56	.94
20	3.29	1.35
21	4.06	1.45
22	3.79	1.52
23	2.89	1.27
*24	3.85	1.54
25	3.65	1.18
26	3.31	1.27
*27	4.58	1.05
28	2.66	1.22
29	3.19	1.25

*Filler items

APPENDIX G

Correlations Among Items on the I-E Scale

Item	*1	2	3	4	5	6	7	8
2	-15							
3	22	-17						
4	13	10	43					
5	05	-04	12	32				
6	04	22	10	31	-01			
7	27	13	06	26	-04	-06		
*8	27	-16	-09	05	08	-18	15	
9	-32	20	-40	-29	-11	01	-14	-18
10	-04	-11	27	29	29	-10	-30	-19
11	-01	-09	25	11	22	06	-40	-04
12	25	04	28	45	39	06	00	35
13	21	14	15	18	36	-14	13	04
*14	16	03	00	05	11	-21	03	46
15	-10	13	10	11	03	-06	06	-12
16	-05	04	04	04	07	-10	11	-13
17	-06	15	23	23	01	10	03	-14
18	15	-06	39	24	23	-29	13	-10
*19	-13	02	09	01	-17	32	-36	-29
20	-07	29	-14	12	16	37	07	-03
21	03	20	14	-05	-00	05	01	-25
22	12	-34	26	26	20	-03	-07	22
23	-27	18	11	14	12	22	-28	-26
*24	14	04	48	16	13	-19	-03	23
25	-16	-04	27	04	13	-10	-03	-09
26	-21	04	03	-10	-31	08	-04	-06
*27	15	-19	-03	-10	-16	-18	24	34
28	-01	29	45	37	18	17	10	-14
29	-07	17	-05	08	05	46	-11	-22

*Filler items

APPENDIX G (Cont'd)

Correlations Among Items on the I-E Scale

Item	9	10	11	12	13	14	15
2							
3							
4							
5							
6							
7							
8							
9							
10	-18						
11	-05	25					
12	-07	24	26				
13	04	02	07	22			
14	46	-18	06	00	-13		
15	32	-07	17	03	26	-30	
16	-06	-06	26	01	09	-35	19
17	05	-08	09	20	23	-44	27
18	-04	29	25	06	30	00	27
19	05	-12	05	-12	-04	-28	17
20	22	-14	13	-11	00	-05	19
21	-21	17	16	-10	22	-22	-15
22	-22	08	03	-30	19	-11	-15
23	08	29	30	-02	16	-47	25
24	-14	10	14	26	18	-19	15
25	23	01	-02	22	35	-21	21
26	09	-06	23	-38	-05	-21	44
27	-10	-20	-14	05	03	17	-12
28	-07	-05	17	15	51	-27	53
29	27	00	16	12	03	-09	-06

APPENDIX G (Cont'd)

Correlations Among Items on the I-E Scale

Item	16	17	18	19	20	21	22
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17	16						
18	20	22					
19	06	25	-01				
20	14	-01	-25	04			
21	12	32	04	10	09		
22	-09	15	00	-04	-28	-08	
23	15	34	00	32	10	26	15
24	-13	11	43	09	-21	-06	32
25	14	22	09	05	15	14	-15
26	26	02	16	29	19	15	-14
27	-27	-16	-04	-19	-24	-25	33
28	24	34	23	18	24	13	-02
29	-30	19	-05	18	08	-04	11

APPENDIX G (Cont'd)

Correlations Among Items on the I-E Scale

Items	23	24	25	26	27	28
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24	14					
25	06	21				
26	22	-07	-07			
27	-10	28	00	-17		
28	29	27	45	20	-13	
29	23	03	-10	-09	-04	06

APPENDIX H

Varimax Rotated Factor Matrix of I-E Scale

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
2	0.17091	0.05819	-0.20043	-0.19506	0.31418	-0.11704	-0.00649	0.28615	0.31118
3	0.12045	0.08343	0.12351	0.74337	0.05404	0.21978	0.27897	0.02903	-0.13268
4	0.17223	0.47850	-0.07982	0.58904	-0.05158	-0.00414	-0.03986	0.18830	-0.07169
5	0.02465	0.71441	0.14633	0.04150	0.04177	0.04870	0.00743	-0.05052	-0.02041
* 6	0.05278	-0.01701	0.03536	0.29302	0.05173	-0.48954	-0.09751	0.60259	0.13760
7	0.10209	0.09478	-0.76395	0.18072	0.05273	0.08365	-0.09688	-0.07926	0.10703
9	0.19911	-0.06075	0.03650	-0.61020	-0.18972	0.01082	0.23714	0.31957	0.15599
10	-0.12540	0.27445	0.48466	0.22575	0.08612	0.25787	-0.07039	-0.03139	0.04758
11	0.28599	0.18272	0.58570	0.13332	0.08218	0.04561	-0.07398	0.01981	0.03581
12	-0.04323	0.62074	0.07605	0.19463	-0.08171	-0.03217	0.17446	0.11638	-0.10813
13	0.27833	0.40204	-0.14023	0.06326	0.30237	0.20311	0.29503	0.00871	-0.16946
15	9.76973	0.02337	-0.00683	-0.09199	-0.12780	0.12824	0.19935	0.05718	0.04988
16	0.38686	0.05975	0.03506	0.04699	0.15753	-0.01670	0.00217	-0.29815	0.07760
17	0.26941	0.07053	-0.03856	0.09841	0.34348	0.10790	0.22291	0.27082	-0.17259
*18	0.30620	0.18141	0.05565	0.21132	0.03660	0.76378	-0.00306	-0.04648	0.09856
20	0.31130	0.22449	-0.00602	-0.06643	0.04815	-0.53964	0.01453	0.08775	0.38976
*21	-0.03165	-0.07280	0.11862	0.11457	0.85528	-0.00365	0.05358	-0.06665	0.09534
*22	-0.05387	0.23164	0.05256	0.16910	-0.01967	0.01176	-0.09415	0.06073	-0.85168
23	0.32923	0.05784	0.38476	0.00075	0.34508	-0.07421	0.01099	0.26769	-0.14479
*25	0.11897	0.14283	0.02383	0.02149	0.07316	-0.01126	0.86402	-0.10338	0.10482
26	0.63733	-0.45243	0.17539	0.04772	0.07662	-0.02604	-0.15810	-0.07691	0.09499
28	0.59568	0.20499	-0.10492	0.28879	0.21934	-0.03480	0.40202	0.13335	0.01672
*29	-0.05786	0.09000	0.10943	-0.08560	0.02483	-0.01831	-0.04496	0.76327	-0.04239

*Items subsequently removed.

Note: Filler items not included in analysis.

APPENDIX I

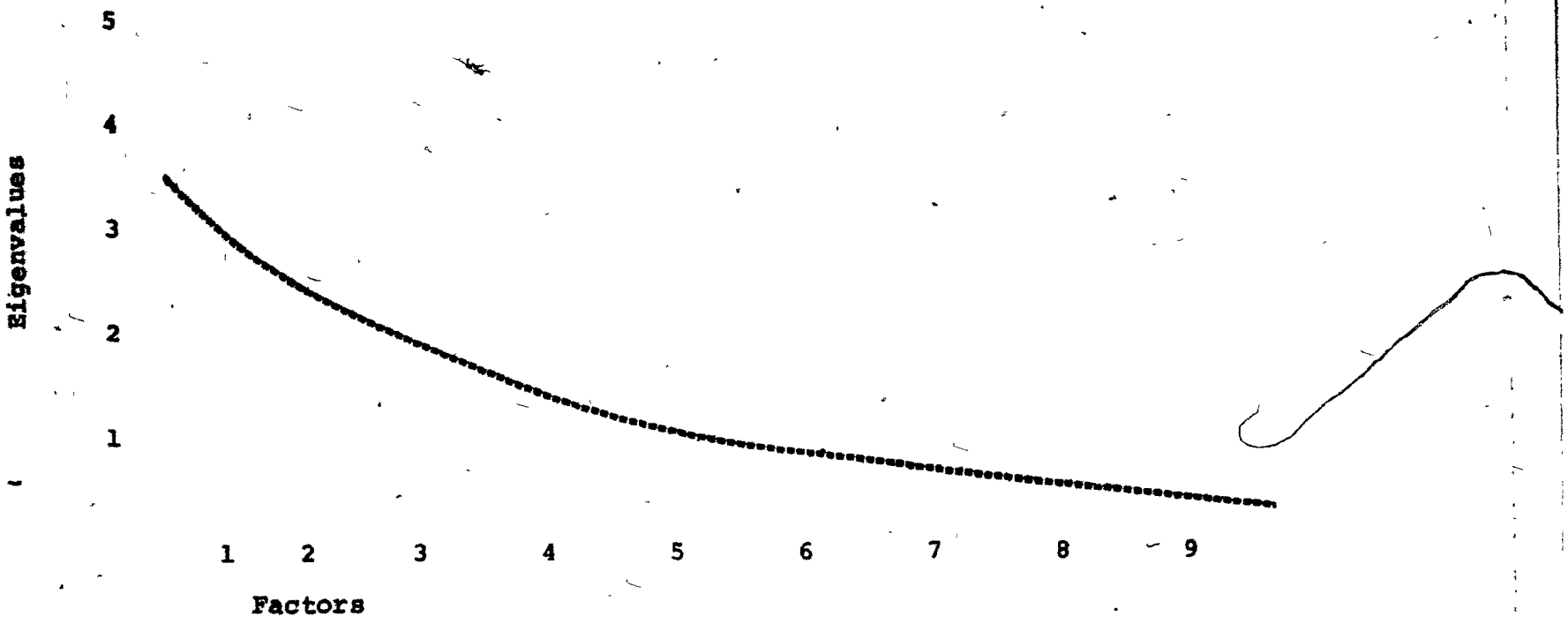

Figure 2: Scree test on I-E Scale Factors (cf. Cattell, 1966)

APPENDIX J

Frequencies of Responses for Each Item on the Control Questionnaire

Item	1	2	3	4	5	Missing
1	5	6	25	10	2	0
2	0	9	11	13	15	0
3	12	11	15	7	3	0
4	3	3	15	17	10	0
5	4	11	9	17	7	0
6	7	10	16	11	4	0
7	2	15	14	13	4	0
8	1	5	16	15	11	0
9	2	6	18	13	9	0
10	8	7	14	11	8	0

APPENDIX K

Means and Standard Deviations per Item on the Control Questionnaire

Item	Mean	Standard Deviation
I	2.96	.97
2	3.71	1.11
3	2.54	1.20
4	3.58	1.09
5	3.25	1.21
6	2.90	1.17
7	3.04	1.05
8	3.63	1.02
9	3.44	1.07
10	3.08	1.31

APPENDIX L

Correlations Among Items on the Control Questionnaire

Item	1	2	3	4	5	6	7	8	9
2	35								
3	06	-10							
4	-02	21	-12						
5	-05	00	12	16					
6	13	37	01	17	14				
7	23	03	25	07	-11	12			
8	09	22	-23	18	13	-30	-46		
9	08	-07	-00	20	01	-18	31	-12	
10	30	09	05	34	09	12	43	-17	49