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The Effects of Reinforcement Schedules on Student Time-On-Task Behavior and Motivational Level in Computer Assisted Learning

By

© Keith A. G. Morrison

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Acknowledgements

Educational research would merely be an activity of shallow theorizing if it were not for the practitioner and the natural school setting. With this in mind, it is with gratitude that the subjects who eagerly accepted to participate in this endeavor and their families who provided informed consent are acknowledged. Likewise, the divisional and school administrators who granted the author permission to conduct this study are hereby thanked. To Paul Laroque who provided the naturalistic math classroom and students and to Lesley Small who was the computer proctor, the author extends his appreciation.

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Abstract

Much of recent Computer-Assisted Learning (CAL) research has investigated learning gains (Anand and Ross, 1987; Dalton, 1985). Little work has been conducted on how computer software can affect a student's level of motivation. Although CAL program evaluating agencies refer to programs as being motivational, a clear explanation of what criteria is used in making these decisions is not evident. Is there a design principle regarding student time-on-task behavior that should be incorporated into CAL courseware?

The theory of Causal Attribution professed by Weiner (1979) provides a theoretical foundation for the establishing of a motivational design principle for academic activities. However, studies applying Weiner's ideas in a naturalistic school setting using a realistic academic task administered by a computer have not been conducted.

The present study was conducted using a quasi-experimental design following a time-series format. The twenty-one grade eight subjects of the convenience sample were divided into groups consisting of matched triplets. Each group was randomly assigned to one of the three feedback schedules (100%, 25%, 0%). Performance rates and achievement levels were recorded for the sixteen drill and practice computer trails. Data regarding causal

stability, certainty ratings and resistance to extinction were collected on four computer trials in an attempt to test some of the tenets of Weiner's theory. All data was analysized using non-parametric statistics with a set alpha level of 0.05. Locus of Control data was compared to all other dependent variables using the Spearman Rank Correlation Co-efficient.

The results of this study indicate that Weiner's Theory of Attribution is applicable in a natural school setting using a realistic academic task. It is believed that a CAL design principle regarding feedback schedules and individual student differences in terms of student skill level and self-concept has been established by this study. Evidence supports the idea that drill and practice software is beneficial in enhancing the development of basic computation skill levels (automaticity) within students. The notion that Locus of Control is not related to other dependent variables is supported.

CHAPTER ONE

Justification for the Study

Weiner's theory. Psychological theories of motivation have been formulated and developed over generations. In most cases, a more recent theory has been based upon the foundations of its theoretical predecessor. Such is the case with Bernard Weiner's (1979, 1985) Attributional Theory of Motivation. Based upon the foundations established by Heider (1958), Weiner's ideas have developed and transformed over more than a decade (Weiner 1972; 1974; 1979; 1985). One aspect of this study was the application of some of Weiner's theoretical notions pertaining to achievement motivation in a middle years educational setting. Studies conducted by Weiner et al. (1971; 1976; 1979) consisted of nonacademic tasks administered to university undergraduates in a contrived experimental setting. Unlike the methods employed by Weiner, this study employed a computer assisted learning (CAL) academic task within a naturalistic educational setting involving middle years students. The purpose was to test the tenets of Weiner's attribution theory in an ecologically valid setting using a common place academic task.

CAL research. A second aspect of this study addresses the fact that the majority of researchers who have investigated Computer Assisted Learning (CAL) practices have been concerned with increased learning gains produced by teaching methodologies utilizing computers (Anand and Ross, 1987; Dalton, 1985; Stroneburg, 1985). Studies designed within an established theoretical framework to investigate how student motivational levels are influenced by the characteristics of various CAL reinforcement schedules are extremely scarce. This study was designed to fill the apparent void in empirical investigation.

Introduction to the Problem

Introduction. Teachers have always been concerned with the amount of overt time-on-task behavior that their students display during classroom activities (Jaeger, 1985; Ferrell, 1985). Mathematics teachers, for example, might wonder how an educator can effectively keep a student's attention directed toward a computation exercise rather than on daydreaming or chatting with a friend. The same teachers may then question whether strategies used to maintain a middle years student's level of attention are the same required at the secondary or primary levels. The apparent need for level specific instructional strategies to motivate students may have influenced how educators responded to CAL (Kearsley, 1977).

Computers and motivation. The introduction of computers into education was accompanied by the hope that this innovation in the delivery of instruction would motivate students. It was soon discovered that computers, in and of themselves, were not always effective motivators of student behavior. Some researchers argued that specific computer program characteristics motivated students (Seymour and Sullivan, 1986; Mosley, 1984). Walker and Hess (1984) have argued that there are fundamental computer program design principles that must be followed in order to maintain high levels of student motivation. They have also contended that more information pertaining to such principles and their characteristics must be collected through research.

CAL evaluation. The writers of software evaluations reported by such groups as EPIE, MicroSIFT and Alberta Education tend to assume in their reviews that innovative programs that use such frills as sound generation, colour graphics, and figure movement provide motivation to students (Infotech, 1987). However, the evaluation criteria of such reviews in regards to CAL design principles are not outlined by these reviewing groups.

CAL research trend. The technology related to computer hardware is developing at a rapid rate. Educational researchers have attempted to keep pace with hardware advancements. Many studies have attempted to legitimize and rationalize innovations produced through technological wizardry such as the effects of coloured graphics on student learning rates (McKenzie, Elton and Lewis, 1978), the applicability of voice synthesizing equipment interfaced with computers (McGuire, 1983), the economic feasibility of instruction using computers interfaced with videodisk equipment (Richards, Halle and Chapman, 1983) and the relationship between CAL and artificial intelligence (Gable and Page, 1984; Bregar and Rood, 1980). The fact that technological innovations open up new commercial markets can be seen as constituting the justification for continued research that is aimed at establishing the viability and applicability of the new technological advancements. Emphasis on hardware related research has resulted in an apparent shortage of required investigations related to software concerns. Are the necessary courseware design principles for motivating student time-on-task behaviors known and utilized?

Need for research. Fundamental questions pertaining to computer assisted learning and the individual needs of specific student populations have been left unanswered in the wake of rapid technological research and development (Geibprasert, 1986; Merrill, 1985). Consequently there is a need to investigate and uncover basic CAL courseware academic and motivational design principles. Such research activities will produce necessary evidence supporting theoretical foundations for future CAL developments and applications in the field of education.

Purpose of the Study

Feedback affects performance. The main purpose of the present study was to discover if there was a relationship between three different types of feedback schedules and student performance levels on a basic decimal number calculation task.

The feedback schedules used in this study were: i) 100% feedback, each student response produced feedback statements immediately; ii) 25% feedback, student responses would randomly evoke feedback statements on the basis of a one to four ratio; ii) 0% feedback, student responses did not evoke any feedback statements.

Courseware design principle. The assumed relationships under investigation may reveal a courseware design principle that should be followed by courseware designers producing drill and practice programs in mathematics aimed at middle years students.

Testing of Weiner's theory. The purpose of the present investigation was to test particular elements of Bernard Weiner's Attributional Theory of Achievement Motivation in a naturalistic school setting using a realistic academic task. In other words, does Weiner's theory apply to the real world that it attempts to explain?

Questions of the Study

CAL program characteristics. Many CAL programs designed for a middle years school population have been developed in the area of mathematics. Results of a sampling of middle year courseware revealed that most programming has been produced in the area of mathematics as opposed to the other academic subject areas. Results of further investigation indicated that 30 percent of all middle year courseware consists of drill and practice material (Morrison, 1985). Explicit characteristics of feedback scheduling incorporated in drill and practice programming and the influence that such scheduling has on the middle year learner's behavior are not addressed by courseware evaluators (Infotech, 1987). Indeed, there is a certain ambiguity in current courseware evaluation practices.

Questions of CAL practice. The net result of such evaluation practices is the raising of some rather pertinent questions. Questions that have gone unanswered regarding the topic of CAL practices at the middle years level. Educators question the appropriateness of drill and practice routines in mathematic instruction. Do we know enough about feedback procedures and schedules to effectively incorporate them into middle years courseware? The questions of this study are established to shed light on such areas of ambiguity.

Questions of the present study. The present study was designed to address the following general questions:

1) Are there CAL design principles regarding feedback scheduling that will increase student motivation levels resulting in an increase of time-on-task behavior when they are incorporated into courseware designed for a middle years school population?

2) Is the condition of 100% immediate feedback in computer programs necessarily the most appropriate format for middle years students?

3) How will varying schedules of computer delivered feedback

influence a student's time-on-task behavior for an academic task?

4) Is there a principle of motivation that can be applied in a natural school environment regarding an actual academic task?

Independent variables. The general independent variable of this study refers to the feedback schedules of the computer program. The three specific variables related to feedback conditions are:

1) 100% immediate feedback.

2) 25% random, immediate feedback.

3) 0% feedback (control).

Dependent variables. The dependent variables investigated by the present study can be divided into two categories. The first category can be described as student academic characteristics. The related variables of this category are:

a) Performance rates.

b) Achievement levels.

The second category of dependent variables can be referred to as psychological consequences. The dependent variables incorporated into this category are:

a) Certainty Level (of future achievement).

b) Stability (of perceived causal attribution).

Meanings for the terms used in this study are provided in Table 1. Operational definitions are included for those terms that require such elaboration.

Table 1

Definition of Terms

Term	Definition
Performance	Measured by the number of questions attempted by the subject per computer trial. This is assumed to be an overt behavior that indicates the motivational level of the student.
Achievement	Measured by the number of questions successfully completed by the student per computer trial. Achievement is reported as a percentage and it is assumed to be an indication of the student's developed competency with the skill involved.
Persistance	The continuation of students attempting questions regardless of the outcomes of their efforts.
Feedback	Refers to any information given to the student by the computer program. Feedback statements may include one or all of the following pieces of information depending on the feedback

schedule employed by the program:

a) Statements indicating whether a response was correct or incorrect.

b) The use of the subject's first name in feedback statements.

c) Praise for a correct response.

d) The correct answer is given following an incorrect response by the subject.

e) Performance and achievement information.

Feedback Conditions

Conditions associated to the schedule that feedback is administered to the subjects. The three conditions employed in this study are the independent variables. They are:

a) 100% immediate feedback; every student response receives feedback immediately following the response's entry into the program.

b) 25% random, immediate feedback; student responses receive feedback on a random variable ratio of one response receiving feedback for every four responses made. When a statement is to be made, it is done so immediately after the student has entered a response into the program.

c) 0% feedback; no feedback is received by the students. This is the control condition of the experiment.

Locus of Control	Psychological construct regarding an individual's perception of reinforcement being contingent upon one's own behavior (internal) or as a result of forces beyond one's control (external). This will be measured by the Intellectual Achievement Responsibility (IAR) Questionnaire.
Computer Assisted Learning (CAL)	Changes in performance and achievement resulting in a student's academic skill or capability as a result of computer delivered instruction.
Computer Assisted Instruction (CAL)	A teaching method which incorporates computers as the medium of academic instruction and evaluation.
Hardware	The physical machine used to deliver programs; example: the micro-computer which includes a

central processing unit, keyboard, monitor and disc drive.

Software — The program produced that enables the hardware to complete specific functions.

Courseware — Computer software designed primarily for academic related subjects and skills.

Drill and Practice Program — A program that displays a question and requires the student to make an input. Function of the program is to provide practice of skills not to impart knowledge.

Certainty — The degree to which students believe that their prediction of future achievement will come true. Certainty is measured on a likert-type scale ranging from a low degree of 0 to a high degree of 10.

Causal Attribution — The perceived cause of achievement level reported by the subject.

Causal Stability — Refers to the perceived causal attribution, a measure of whether the cause is perceived to be stable or unstable. Stable causes are seen as being invariant over time, enduring characteristics of either the subject or the situation. Unstable causes are seen as being variant over time, a temporary condition that can be changed or altered. Causal stability is measured by the Causal Dimension Scale in this study.

Motivation — The degree to which students continue to respond to drill and practice questions regardless of the outcome of those responses. Levels of motivation are indicated by performance rates.

Middle Years Students — Students attending grades 5 through 8 with an average age range of 10 years to 14 years.

Organization of the Thesis

Chapter 1. The first chapter provides the reader with an introduction to the problem upon which this thesis was based. The purpose and justification for the present study are also outlined. Terms pertinent to the investigation have been defined and the questions of the study are presented.

Chapter 2. "The Review of the Literature" will refer to the following areas of psychological thought:

1) Biological based theories.

2) Behavioral theories.

3) Cognitive-Field theories.

The literature review will illustrate how each area of thought explains human motivation; what factors create motivated behavior, how motivation is directed and how motivation is related to learning. Developmental links between the areas of thought will be established illustrating how previous theoretical notions have been built upon to form more encompassing theories. This will form an introduction to the presentation of Bernard Weiner's Attributional Theory of Motivation which will be outlined in relation to the present study. Literature pertaining to computer related research will be included in Chapter 2. Topics covered will include a rationale for the use of CAL practices, associated student learning gains through CAL activities, characteristics of programs and the CAI Phenomenon. The chapter will conclude with a call for recommended research, an overview of the present study's purpose and justification and a listing of the hypotheses of this study.

Chapter 3. The third chapter provides the reader with the specific characteristics of the experiment conducted. Sample description, experimental procedures and statistical methods are included.

Chapter 4. This chapter is the result section of the experiment. Statistical methods and results are illustrated.

Chapter 5. A discussion based on the results of the study. Limitations of the study, generalizability of the results and recommendations for future research are discussed.

CHAPTER TWO

Review of the Literature

The Development of Motivation Theory: A Historical Perspective

Introduction

Research viewpoints. Since the time human behavior was first observed people have been asking themselves "why". What are the explanations for the actions of others that we have observed? The manner in which particular researchers design studies to answer questions about behavior will be directly influenced by their theoretical foundations. A researcher following a biological line of thought may investigate the connection between observed behavior and inherited instincts. A behaviorist's study may concentrate on the influence that environmental conditions had on the individual in producing an overt behavior. The social psychologist would add a cognitive element to the environmental conditions to help explain the behaviors of humankind. All theories of motivation are based on sets of assumptions which direct the researchers' questioning. Therefore, the questions asked about a specific behavior emitted in a particular situational context will depend on the researcher's theoretical viewpoint. Answers or explanations for the same behavior will vary depending on the specific viewpoint being followed by a researcher.

Section organization. This section of the thesis provides the reader with an introduction to following areas of psychological thought:

1) Biological based theories.

2) Behavioral theories.

3) Cognitive-Field theories.

The review will include the assumptions incorporated in the theories pertaining to:

a) Explanation of human motivation.

b) How motivation is directed.

c) Human learning.

Developmental links between the fields of theoretical thought will provide the reader with an understanding how motivation theories have built upon previous ideas to produce a progression of psychological thought.

Biological Based Theories

Darwin. The concept that the behaviors of humans were linked to the motivational processes and instincts that were characteristics of lower level organisms of the animal kingdom was championed by Charles Darwin (1929). The theory of evolution essentially states that instincts were unobservable motivational forces. Innate behavioral tendencies of organisms were considered to enable them to respond to stimuli. Certain stimuli such as hunger, thirst and pain were considered to be motivational agents.

These agents produced behaviors designed to eliminate them (Darwin, 1946; 1948). They operated within the animalistic instincts of territoriality and aggression. These instincts have accompanied organisms throughout the evolutionary process (Ardrey, 1966; Lorenz, 1966; Tinbergen, 1951). The survival of the organism depended upon the performance of the motivational agents to produce necessary behaviors (Korman, 1974).

Influence on motivation. From Darwin's (1859) early work, two fundamental concepts can be derived that have had an influence on the study of psychology of motivation. Firstly, depending on the environment of an organism, its survival and reproduction was seen as being a function of how well the species fit into its surroundings. Secondly, as the members of a species survived and reproduced, characteristics of the organism changed. Other organisms of the species world died off if they did not successfully adapt to an environment (Korman, 1974).

Dualism. Of what importance could these findings of a biologist be to the study of motivation? Darwin's central tenets challenged the beliefs of dualism. According to the beliefs of dualism, animals operated on instincts and humankind operated on intelligent, rational choice. Once similarities between the functioning of lower ordered animals and humankind were established, the foundations of dualism were shattered (Korman, 1974). Darwin's theory suggested that there existed a probability that a knowledge of animal physiology and processes (experiences and behavior) would shed light upon human experiences and behaviors (Fletcher, 1968). This thought produced the notion that scientists could study human processes the same way as they had been studying animal processes. The notion has guided work in psychology ever since.

Instincts. Darwin's concept that basic instincts were determinants of behavioral arousal led to the development of two distinct avenues of psychological activity. Theorists such as William James (1890) and William McDougall (1908) developed lists of instincts. They maintained that instincts were mainsprings of all kinds of behaviors. Human behaviors could be explained by the use of instincts whether they were simple or complex, necessary or unnecessary for biological survival of the organism.

Motivation. The second avenue of thought (the one explored by this thesis) attempted to utilize innate mechanisms of biological survival as a theoretical foundation to explain human behavior. A framework of ideas designed to explain human motivation of a complex, nonbiological nature was constructed upon that foundation. One such theorist of that tradition was Sigmund Freud.

Psychoanalytical theory. Freud (1940) developed a comprehensive theory of motivation which was very much rooted in biology and influenced by Darwin's ideas. The Psychoanalytical

Theory of Motivation was based on two instinctual sources of motivation (sex and aggression) combined with neurological assumptions.

Instinct satisfaction. Freud saw people as being continually forced to adapt to the demands of their environment. Adaptions enabled the individual to achieve instinctual gratification. Like Darwin, Freud regarded survival in the environment as being dependent upon satisfying one's instincts. The mechanisms which operated within people to produce the adjustments were assumed to be unlearned and innate in nature. The most fundamental adjustments or accommodations occurred in the earliest years of a person's life. These adjustments were considered to be formative in the development of personality and influential in future developmental trends of the individual.

Cognitive processes. The theory regarded cognitive processes are being significant in that it is instinctually influenced thinking that initiates behavior. However, according to Freud and others (Tolman, 1960; Kubie, 1950) conscious volition and choice have little impact on behavior.

Learning. In regards to the learning process, the Psychoanalytic Theory placed a fundamental importance on the affective aspects of an individual's experience. Learning itself would take place in order to deal with specific environmental conditions that created a need for instinctual gratification.

This accommodation of the individual guided by the affective elements of experience to the conditions of the physical and social environment is the basic core of the process of learning (core learning).

Institutional learning. Individuals learning within an institutional framework (school, university) must adapt more consciously as compared to core learning. Learning in a school will always be superimposed upon a previously established body of affectively oriented learning (Fletcher, 1968).

Application to contemporary education. What do the proponents of the biological viewpoint indicate to educators today? Must we have a knowledge of a species' innate predisposition before we can understand the learning process? Should we develop strategies of instruction that produce the same pleasurable affects related to early infant experiences associated to a caring mother? Or are their ideas merely the foundation for other psychological ideas? Indeed it is difficult to divide theoretical camps into separate and distinct categories. There is much in the way of overlap between the areas of psychological thought which have been influenced and inspired by Darwin and Freud.

Freud's influence on dualism. Freud's work, in essence, was a final blow to the idea of humankind's use of rational will as being the only determinant of the direction, choice or persistence of overt behavior. Behaviors reflected instinctual drives which were disguised and distorted by the pressures and constraints of society. To understand motivational processes, people must look at the antecedent variables that led to behaviors. From Freud's time on, the basic argument for understanding the motivational process was that behavior varied because of antecedent variables. Therefore, theoretically, researchers could understand, measure and predict behaviors before an individual emitted them.

Behavioral Theories

Early theorists. A concept incorporated within the Theory of Evolution is that instincts are sources of motivation (McDougall, 1908). It was also believed by the proponents of the theory that the instincts found present in the chain of human relatives (lower order primates) should also be present to some extent in people (Ardrey, 1966; Lorenz, 1966; Tinbergen, 1951). The psychologists of the early twentieth century proposed that such instincts were unobservable motivational forces responsible for the behavior emitted by people. By 1924, a list of 14,000 instincts was compiled and used to explain all human behavior. Woodworth (1918) questioned the indiscriminate use of instincts and replaced the term instinct with the term drive. Drive maintained the traditional Darwinian notions which previously applied to instincts. Psychoanalytic theory (Freud, 1940) maintained the term instinct but American behaviorism was to popularize the drive concept.

Pavlov's background. Behaviorism was developed in the United States of America in the early 1900's. The theoretical structure was conceived in Russia during the late 1800's with the advent of Pavlov's Classical Conditioning. Pavlov was a physician and a physiologist so his ideas related to psychology were influenced by his biological background. Working on studies designed to explore dog salivation under differing conditions, Pavlov stumbled upon the question of how mental associations were produced within organisms (Owen, Blount, and Moscow, 1978).

Classical conditioning. Aristotle had noted that if particular items (things or events) occurred closely together and frequently, they tended to become associated within the observer's mind. Pavlov and Classical Conditioning provided Aristotle's theoretical notions with an actual mechanism that created the phenomenon (Owen, Blount and Moscow, 1978). According to the conditioning model, an unconditioned stimulus (UCS; a natural, uncontrived external event) will cause an organism to produce an unconditioned response (UCR; unlearned response elicited by the environment). When a UCS is paired (presented in close temporal proximity) with a neutral stimulus (evokes no real response in the organism), the once neutral stimulus will eventually elicit the UCR when presented to the organism without the UCS. The neutral stimulus was then called the conditioned stimulus (CS) and the once UCR was then called the conditioned response (CR). Motivation in classical conditioning is found in the stimulus. Pavlov thought that appropriate pairings of stimuli would produce learning.

Extinction and generalization. Pavlov investigated two other processes within the conditioning model. The process of extinction was shown to occur with repeated exposure of the CS to the organism without the UCS. Eventually the CR disappeared and became extinct. The process of generalization occurred while the organism was still conditioned. When the organism was exposed to a stimulus similar to the CS, the CR would be emitted. The more similar the general stimulus was to the CS, the greater the degree of the emitted CR (Owen, Blount, and Moscow, 1978; Marx and Tonbaugh, 1967; Ferster and Culbertson, 1982).

Contemporary application. Can this classical conditioning model be applied to a classroom environment, specifically one that has been augmented by the use of computers? In classical conditioning, the UCR (later to become the CR) is of an involuntary, biological nature. Contemporary psychologists (Vernon, 1972) have experimentally incorporated classical conditioning procedures in explaining human affective (emotional) responses. Let us look at a hypothetical example. Students working on the computer are presented with an UCS of praise for questions they answer correctly. This is followed by the involuntary UCR of feeling good and attempting more questions. The students in the example are presented with computer delivered UCS (praise) for every question they attempt. When these students return to the real classroom where CS (teacher praise) is much less than 100% for the questions the students attempt, the CR (good feeling and continued attempts at questions) will eventually succumb to extinction. But if the UCS of the computer was more in line with the CS of the classroom, perhaps an answer/praise ratio of 4 to 1, generalization would occur within the students and the CR would be maintained.

Higher-order conditioning. Pavlov's work also included higher-order conditioning. When another once neutral stimuli is paired with a CS enough times, the neutral stimuli become yet another CS which elicits the same CR. The process of linking a CS with a new CS is called higher-order conditioning.

Classroom application. This also seems to apply to a classroom situation. Let us return to our example. Our UCS is praise from the computer. It elicits the UCR of good feelings within the student. The UCS has been paired with a CS of teacher praise and perhaps the once neutral stimuli of being in math class. Math class becomes another CS producing the same CR of good feelings. This would be considered beneficial higher-order conditioning.

Individual differences. Classical Conditioning also maintained an awareness of individual differences. Intensity of responses differed between each of Pavlov's dogs. This variety of responses made it impossible for Pavlov to be absolutely certain in predicting that a CS would produce an expected response. The same is true in schools today. All students will not respond to the stimuli of a lesson the same way. Teachers must always take into account individual differences (Owen, Blount and Moscow, 1978).

Thorndike. E. L. Thorndike was also a theorist within the classical conditioning framework. As did Pavlov, Thorndike considered motivation to be held by the stimulus. He believed that the bond between a stimulus (S) and the response (R) it elicited would be strengthened by a reward. As the frequency of the rewarding of a specific S-R pair increases, so too did the strength of the bond. Eventually, the stimulus could be presented to the organism and the response had to be performed regardless of there being a reward. The response would become ingrained in the organism's behavioral repertoire. This phenomenon came to be called the Law of Effect (Thorndike, 1911).

Law of effect and learning. How can the Law of Effect apply to an educational setting? Let us consider the stimulus as being a question presented to a student. The student attempts to answer the question. For this, the teacher rewards (praises) the student's efforts. If this configuration is repeated on numeral occasions the S-R bond will be strengthened. According to the law, every time a conditioned student was exposed to the S (question presented), the student would attempt to answer it. Is this not a principle of CAL? Does this not suggest that a student's rate of performance will be greater if a CAL program rewarded every student response? Further implied by this law is that a 100% reward schedule on a CAL program will produce a student who will have a higher performance rate once that student has returned to the regular classroom. Does this actually occur in a real school environment? Does this idea not contradict Pavlov's work with extinction?

Stimulus and motivation. Pavlov and Thorndike can be considered early learning theorists. Both believed that the stimulus held the motivation and that such motivation was a segment of the learning process (Arkes and Garske, 1977).

Watson. Classical conditioning established a starting point for the development of behaviorism. The American psychologist John B. Watson (1913), while being a professor of experimental and comparative psychology, proposed a theory of behaviorism. His ideas centred upon the doctrine of determinism. That doctrine stated that external events controlled the course of all human and animal action. His work with rats and Pavlov's work with dogs supported this idea. Watson added to determinism the notion that behavior could be changed and controlled by the altering and arranging of external stimuli.

Scientific approach. Another tenet of Watson's ideas was that the study of psychologists must be scientific, confined to external and observable events. Early S-R psychologists such as Pavlov (Thorndike, 1911; Cannon, 1929) believed that the responses to a stimulus were due to either an innate reflex or to learning. Indeed more contemporary behaviorists would not ignore the existance of such processes as thinking and feeling within humans. Since innate reflexes, thinking and feeling are unobservable and could not be measured in a scientific manner, behaviorists directed their study of learned behavior scientifically by ignoring such unobservables. The degree to which subsequent theories maintained a scientific approach in dealing with learning varied greatly. The theory of motivation developed by Clark L. Hull and Kenneth Spence (Hull, 1943) is an example of a science oriented behavioristic theory that did include unobservable and assumed constructs.

Influences on Hull. Hull's ideas were influenced by the tradition of classical conditioning and the behaviorism of Watson. Hull was a behaviorist in that he studied observable stimulus and response situations. However, he also hypothesized about unobservable processes and states he referred to as drives. Drives were intervening variables that were assumed to exist between the stimulus and response (Hull, 1943). The notions of drive and intervening variables resembled the ideas held by Freud's (1940) psychoanalytic theory.

Motivation model. Hull's (1943) model of motivated behavior included habit (H; established within the individual by practice and rewards), motivation or drive (D) and a behavior or performance (E). The model of motivated behavior was based on the results of experiments conducted with rats by Perin (1942) and Williams (1938). Hull assumed that H and D contributed equally to E. Therefore, E=DxH was the developed formula. In 1943, the theory assumed that biological needs were the sole sources of motivation. A belief similar to that held by earlier biologically based theories regarding humans (Darwin, 1946; Woodworth, 1918; Freud, 1940). Reduction of such biological needs was seen as reinforcement for behaviors. This idea resembled Freud's (1940). Reduction of such biological needs was seen as reinforcement for behaviors. This idea resembled Freud's (1940) instinctual sources of motivation. For Freud, performance was directed toward instinctual gratification while Hull saw performance as an attempt by the individual to reduce needs. The biological need reduction aspect of Hull's work was later disproved by the studies of Sheffield and Roby (1950).

Challenges to the model. Hull's theory underwent modifications in attempts to explain empirical evidence that confounded his notions. Ideas such as performance due to goal anticipation (Tolman and Honzik, 1930a), the existence of latent learning (Blodgett, 1929; Tolman and Honzik, 1930b) and the effects of reward size on performance (Crespi, 1942 and 1944) technically put an end to the applicability of Hull's 1943 theory.

Incentive. Hull's (1952) final revision of his behavior model included the variable of incentive (K), E=DxHxK. Hull's attempt to provide explanations for phenomena served to complicte the matter. Although Hull's theory may not have been directly applicable to the explanation of the human learning process, it did inspire studies that have shed light upon the learning phenomenon.

Application to CAL. Can Hull's model explain what occurs in a learning situation involving a computer? Hull would maintain that a learning process that uses rewards would establish H (habit). Therefore, a CAL program that reinforces (or rewards) correct answers will develop in the student the habit of correct responses. Let's say our student is faced with a major test. This situation may cause a certain amount of anxiety which may be seen as the biological drive (D). Indeed, the teacher may offer the incentive (K) of future examination exemptions if test scores are high. Since E = DxHxK and the levels of all variables are relatively high (H due to the CAL program), the performance E (correct responses) will most likely occur under these conditions rather than a situation where the habit was not developed. But what if the student is worried about the results of the test? E has served to create a drive rather than reduce one. The unobservable D does produce problems in the understanding of the formal learning process.

Perception of Hullian thought. Hull's S-R model, and the philosophical premises behind it, were seen by the public as a lowering of humans to the level of animals. In fact, Hull contended that when any organism was stimulated by the environment it would emit a predicted response in a machine-like fashion. Hull is not the only psychologist to be painted with such a brush of unpopular public opinion. Another behaviorist following the S-R tradition, B. F. Skinner, proposed ideas which required humankind to once again re-examine themselves.

Early Skinner. Skinner (1938) in his early work referred to drives such as hunger and thirst in relation to human behavior in a similar manner as that used by Hull (1943). In his later work, Skinner (1950) disapproved of the use of intervening variables such as hunger and thirst in explaining human actions. He considered that the use of such unobservable variables to explain phenomenon retarded scientific progress. Skinner held the viewpoint that all unobservable theoretical constructs should be discarded from science. This included discarding the construct of motivation. To this end, his theory can be seen as a nonmotivational theory that echoes the ideas of Watson's (1913) radical empiricism while on the other hand, dismissing Hullian theory.

Behavior prediction and control. According to Skinner (1974) the purpose of psychology was to predict and control the behavior of individual organisms. There was no place in his vision of science for unobservables or the idea that organisms were the originators or initiators of actions. Learning could be defined by Skinner as being changes in either the form or the probability of responses. Such changes were brought about by operant conditioning (Bigge, 1982).

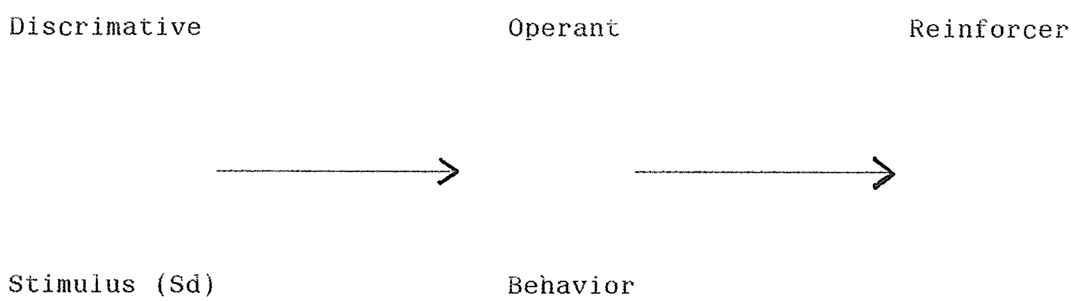
Operant conditioning. Operant conditioning (also referred to as instrumental conditioning) is a learning process that develops a response pattern in organisms that is more probable or more frequently emitted. An operant, or set of actions that make up a behavior, are said to operate upon the environment whereby causing consequences. An individual's operants can be strengthened (high probability of being emitted in the future) through reinforcement. Therefore, operant conditioning is the process of responses (behaviors) being modified or changed by an environmental agent (perhaps a teacher) using various reinforcement techniques (Bigge, 1982). As Skinner (1972) said, all behavior is a product of operant reinforcement. The task of the psychologist is to gain an increased understanding of the conditions under which reinforcement works best. Skinner saw this situation as leading the way to cultural control through social engineering.

Resemblance to classical model. The operant conditioning model resembled that of earlier S-R theorists (Thorndike, 1911; Watson, 1913) in that it included a stimulus (S) and a response (R). The stimulus was further defined as being a discriminative stimulus (Sd). That referred to the idea that a specific or a discriminative stimulus would evoke a particular response to be emitted by an individual. The association of the specific Sd and a response was strengthened by repeated reinforcement for the individual when that individual emitted R after exposed to Sd (refer to Figure 1).

Contrary to the classical model. The model of operant conditioning does seem to resemble Thorndike's (1911) Law of Effect. As previously mentioned, behaviorism did have its roots in classical conditioning, but there are some fundamental differences. In classical conditioning, the stimulus draws out the response which is normal for the UCS. The response is usually already a part of the individual's behavior repertoire. The notion that human behavior is purposeful was supported by the classical approach but dismissed by the operant approach. The stimulus in operant conditioning does not naturally elicit a desired response. The response must be waited for and it may be new to the individual. Also, reinforcement is contingent on the

Figure 1

The Operant Conditioning Model



(Adapted from Education Psychology: An Introduction (p. 164) by S. Owen, H. P. Blount, and M. Moscow, 1978, Toronto: Little, Brown and Company. Copyright 1978 by Little, Brown and Company (Inc.).)

response in operant conditioning but no such contingency exists in classical conditioning (Marx and Tombaugh, 1967).

Reinforcement. A reinforcer was an event that followed a behavior which changed the probability of that behavior being emitted in the future. When a behavior is reinforced in the presence of a particular stimulus, that stimulus becomes the discriminative stimulus. Contingencies of reinforcement refer to the fact that certain reinforcers follow particular behaviors only (Travers, 1982). These contingencies are used in operant conditioning theory to explain simple to complex behaviors. It is seen as a step up from the basic S-R theories of old (Skinner, 1969).

Positive and negative reinforcement. Reinforcement could be seen as being either positive or negative in nature. When positive reinforcement followed a response, that response in association to the discriminative stimulus will be strengthened (increased probability of reoccurrence). Negative reinforcement is when the removal of an aversive stimulus actually acts as a reinforcer and increases the probability of reoccurrence of the behavior (Wenrich, 1970).

Reinforcement scheduling. The power of behavior change comes through the appropriate scheduling of reinforcement. Ferster and Skinner (1975) report that subtle differences in the scheduling of reinforcements might generate dramatic differences in behavior. A wide range of changes in behavior can be produced through the manipulation of schedules. Such behavior changes prior to operant theory would have been attributed to motivational or emotional variables (Ferster and Skinner, 1957).

There are very many different types of reinforcement schedules. Three schedules are of direct importance to this study. Continuous reinforcement (crf) is when every desired response emitted is reinforced. Variable-ratio reinforcement (VR) is a schedule of reinforcers administered according to a preselected ratio. For example, one in every four desired responses is reinforced. The ratio is set but the administration is on a random basis meaning that it is not every fourth behavior but rather an average of every fourth behavior that is reinforced. Extinction (ext) is a condition under which no response is reinforced. Analysis of the scheduling of reinforcement has proved to be useful in the design of educational techniques for normal human subjects in classrooms. In fact, intermittent reinforcement (VR is an example) constitutes a very influential condition on action (Ferster and Skinner, 1957).

Application to education. Skinner (1968) attempted to apply operant theory in the educational setting. He thought of students as being individuals who were not diligent or eager and who could not make themselves study. If learning was to occur, good instructional contingencies would have to be arranged. The end results of education could not be used during the education process as reinforcers. Other reinforcers such as privileges and favors (contrive proximate reinforcers) and the results of actions (natural reinforcers) must be scheduled. Natural reinforcers are more powerful but almost always have to be rigged in the educational setting. Skinner continued to point out that immediate and consistent reinforcement is desirable. He did mention that intermittent and remote reinforcers cannot be underestimated.

Programmed instruction. Skinner referred to programmed instruction as a scheme for making an effective use of reinforcers. The use of reinforcers shaped new behaviors and maintained the strength of previously acquired response patterns. He warned that frequent reinforcement may reduce the teacher's reinforcing power. The reinforcers which required a teacher may be used more effectively by incorporating them into an intermittent schedule. Through a proper understanding of contingencies of reinforcement, educators should be able to produce students eager and diligent. This will occur through an exposure of students to a gradually lengthened variable-ratio schedule of reinforcement (Skinner, 1968).

Courseware concerns. But is this the case with contemporary CAL courseware? Are educational packages developed in a manner that lengthens the reinforcement ratio? That is, reinforcement has shaped behavior to the point where, (as a student becomes older and more experienced), the reinforcement schedule becomes increasingly intermittent in nature. Are we shaping student behavior with CAL practices in an attempt to develop eager and diligent learners?

CAL practice. The operant conditioning model can be applied to CAL practices quite nicely. An example may be a mathematics (decimal) drill and practice program. Students are exposed to a question and they answer it. Depending upon the correctiveness of their response, feedback following the answer will either praise or correct the student. In this example, the Sd is the computer generated decimal question. The R is the student's response and the reinforcement is the resulting feedback statements. Skinner may argue that a schedule of continuous reinforcement will produce a greater student performance rate (number of questions attempted) than an intermittent (variable-ratio) reinforcement schedule. Indeed, he would suggest that the feedback conditions will affect performance rates more so than a program using an extinction schedule (no reinforcement). Does his theory suggest that the developing of diligent, "motivated" learners is best achieved with the use of intermittent reinforcement scheduling once desired behaviors have been established?

Combination of classical and operant models. If we diverge from radical empiricism for a moment, we can see operant and classical conditioning can be combined to explain behavior. As shown by Owen, Blount and Moscow (1978), the two streams of the S-R tradition do overlap. Returning to our CAL example, the operant Sd was the computer generated question, the R was the student's answer and the reinforcer was the feedback statement. The overlap of the two models occurs with the operant reinforcement. The feedback statements considered to be reinforcers in the operant model are the conditioned stimuli in the classical model. These CS's (positive reinforcers) produce good feelings within the students (refer to Figure 2).

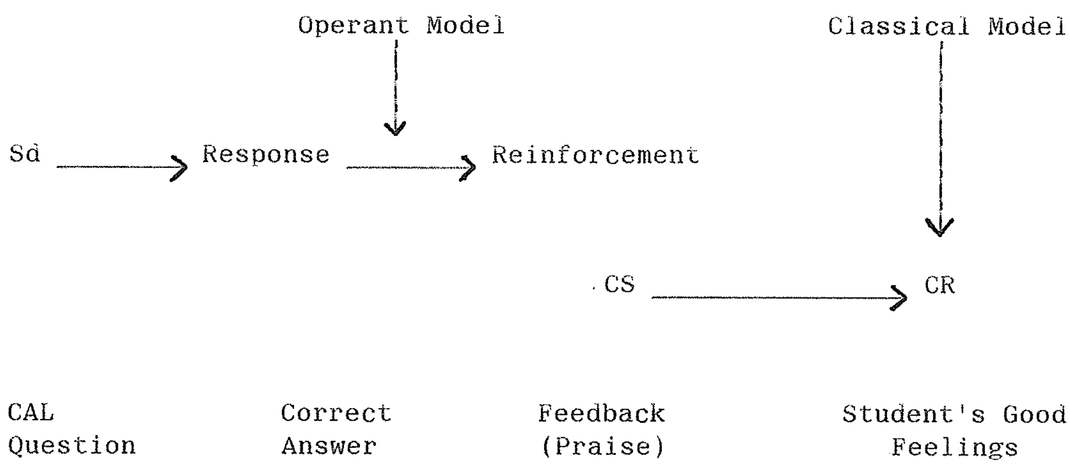
Unobservable constructs. The inclusion of the unobservable "good feelings" does not fit into Skinner's operant scheme at all. But what about the idea of human beings as thinking, purposeful organisms? Skinner's work was an attempt at explaining behavior scientifically. But he was unable to convert all theorists. Indeed, the merging of the classical and operant models seems logical. Therefore, its only logical that psychological theories would develop that included unobservable constructs and maintained a premise that humans are thinking organisms that could initiate and originate behavior.

Cognitive-Field

Gestalt theory. Cognitive-field theories (Bigge, 1982) all have their roots in the early Gestalt theory of Max Wetheimier developed in 1912. Gestalt theory was a response to the trial and

Figure 2

The Merger of Operant and Classical Conditioning Models in Relation to CAL Procedure



(Adapted from Education Psychology: An Introduction (p. 166) by S. Owen, H. P. Blount, and M. Moscow, 1978, Toronto: Little, Brown and Company. Copyright 1978 by Little, Brown and Company (Inc.).)

error learning theory proposed by Thorndike. Gestalt theory emphasized learning through insight. Insight was considered to be the organization of the individual's total field, perceptually and cognitively, in order to solve a problem. For Gestalt psychology, the whole was greater than the sum of its parts (Arkes and Garske, 1977; Bigge, 1982).

Lewin. Greatly influenced by Gestalt principles was Kurt Lewin (1935, 1938). Behaviorism at this time emphasized environmental stimuli in determining the course of human behavior (Watson, 1913; Hull, 1943). Lewin (1935) proposed that human behavior was directed by both the individual and the environment. People were considered to be thinking organisms emitting purposeful behaviors.

Life space. An individual's physical and psychological environments combine to form a life space (Lewin, 1938). Individuals were seen to be located at particular spots in the life space directing their behaviors toward set goals. Forces that caused a person's movement in the life space were Lewin's motivational constructs. Lewin's theory was a theory of motivation more so than a theory of learning.

Criticism. Lewinian theory came under heavy criticism by many theorists (Atkinson, 1964; Bolles, 1967). Much criticism dealt with the manner in which Lewin defined his terms. Lewin's definitions were vague and lacked operational meaning where necessary. The theory did not seem to be well defined or empirically based. Its strength came from the fact that it presented a new way of looking at behavior. Lewin's ideas placed a thinking individual between Hull's S and R. The work was an important ancestor of cognitive theories to follow.

Consistance theories. Extensions of Gestalt theory coupled with Lewinian ideas of cognitions resulted in such theories as Balance Theory (Heider, 1946), Congruity Theory (Osgood and Tannenbaum, 1955) and Cognitive Dissonance Theory (Festinger, 1957) all known as consistance theories. Each set of ideas had limited application to learning per se but they set the foundation for future social psycology theories.

Causal attribution theories. Cognitive-field theories dealing with causal attribution emphasize human cognition. People ascribe causal explanations to the behaviors they emit or to behaviors they observe being emitted by others. Theories of attribution have assumed minimal determinism in behavior. Whereas the psychoanalytical viewpoint assumes a biological basis for motivation and behaviorists assume an environmental basis for behavior causation, attribution theories imply that influence of such determinants is less influential than the attribution an individual makes to such determinants. The emphasis is not on the cause of action but on the perceived cause. This thesis is concerned with the specific Attribution Theory of Motivation proposed by Bernard Weiner.

Bernard Weiner's Attributional Theory of Motivation

Introduction

Theoretical assumption. Weiner's Attributional Theory possesses a central assumption that sets this line of thought apart from theories discussed thus far. The assumption states that the search by an individual to understand his environment and himself is the basic "spring of action" (Weiner, 1979). In a school environment, such a search for understanding may lead students to ask the attributional question of "Why did I succeed or fail?"

Classroom behavior. The classroom is indeed a complicated environment. Motivations are not always achievement orientated. Although the achievement situation is of primary importance to this thesis, one must be cognizant that motivations may be directed toward peer acceptance and social relationships. Individuals continually ask attributional questions regarding their own behaviors or the behaviors of others that they are observing regardless of the direction of the behavior. The unknown is when do people ask "why" questions?

S-C-R model. As is the case with all attribution theories, Weiner (1976) reports that his theory is concerned with the perceptions of causality. This process of perceptions operates within the Attribution Theory's framework of an S-C-R model. S represents a stimulus or antecedent, C represents a causal cognition and R symbolizes a response or consequence. Weiner's model has an electric nature to it. He has borrowed the S-R arrangement from the behaviorists and has added to it the processes of cognition supported by cognitive-field theorists. The final model was designed to explain achievement-related thoughts and behaviors.

Causal Attributions

Theoretical development. The S-C-R model uses the principles of social perception to broaden the cognitive framework of earlier mentioned cognitive-field theories of motivation. Causal attributions refer to the perceived reasons for an individual's success and failure in the area of achievement. Weiner's notion of perception (an idea borrowed from Gestalt theory) was directly connected to motivation. Early work in attributional theory guided by Heider (1958) was further developed by Weiner, Frieze, Kukla, Reed, Rest and Rosenbaum (1971) to create the core of the present theory. The theorists postulated that ability, effort, task difficulty and luck were the causes perceived by people as being responsible for success and failure in achievement related contexts. Weiner (1979) indicated that individuals assign values to the above four causal factors. Individuals' expectancies to whether they will succeed or fail at a future task is based on their perception of their level of ability in relation to the perceived difficulty of the task. Included in this expectation formulation is the individual's estimate of intended effort that will be applied to the task as well as anticipated luck.

Salient factors. By no means do the four causal factors mentioned constitute an absolute listing of all perceived causes. There is a myriad of factors. The four reported here and indicated by Weiner (1971, 1974, 1979) are regarded to be the most salient. Other possible causes may include fatigue, bad mood and teacher bias. The influencing power of causes is related to what causal dimension the individual assigns to each causal factor.

Causal Dimensions

Taxonomy. The theory creates a classification scheme or taxonomy of causes. Causes are placed into categories according to their underlying properties. Causes in the same category share similar characteristics. The three dimensions that form the taxonomy are locus of causality (locus), stability and controlability.

Dimensions. Causes included on the locus dimension refer to those that are either internal or external to the individual. Placement of a cause on this dimension does not imply that it is invariant over time or between people. The dimension of stability, split into segments of stable (invariant) and unstable (variant) causes, refers to this notion of change. Controllable, (referring to causes subject to an individual's volitional control), versus uncontrollable, (those causes not under such control) is the dimension that deals primarily with interpersonal judgments. As illustrated by Table 2 causes can be classified into a taxonomy of eight cells (Weiner, 1979).

Dimensional consequences. Each dimension possesses consequences and implications for an individual's thought and action. Each has a primary psychological function as well as a number of secondary effects. The dimension of stability has a primary relation to the magnitude of expectancy change an individual experiences following a success or a failure. The locus dimension has implications for the student's self-esteem; an emotional consequence of achievement performance. The emotional consequence or affect is a secondary association for causal stability. Affect (value) and expectancy are linked across dimensions in the attribution taxonomy. This characteristic integrates attribution theory with the expectancy-value ideas of motivation purported by Lewin (1935). The dimension of control relates to the interpersonal judgments and actions of helping, evaluation and liking. The Attribution Theory incorporates perceptions from the viewpoints of self and other and considers intra as well as interpersonal behavior (Weiner, 1979). A closer look at the dimensions is warranted.

Table 2

Causes of Success and Failure, Classified According to Locus, Stability and Controlability

Controlability	Internal		External	
	Stable	Unstable	Stable	Unstable
Uncontrollable	Ability	Mood	Task Difficulty	Luck
Controlable	Typical Effort	Immediate Effort	Teacher Bias	Unusual help from others

From "A theory of motivation for some classroom experiences" by B. Weiner, 1979, Journal of Educational Psychology, 71, p. 7.

Stability Dimension

Previous research. The causal ascriptions made by individuals to the stability dimension are based upon their past performances. Researchers (Fontaine, 1974; McMahon, 1973; Meyer, 1978; Ostrove, 1978; Rosenbaum, 1972; Valle, 1974; Valle and Frieze, 1976; Weiner, Niesenberg and Goldstien, 1976) have uncovered empirical evidence indicating that causes ascribed to the stability dimension are important determinants of an individual's future goal expectancies. That is to say, if an achievement outcome (success or failure) is perceived by the student to be a stable cause (unchanging over time) then the outcome (success or failure) will be anticipated to reoccur in the future with a greater degree of certainty. On the other hand, if outcomes are attributed to unstable causes (subject to change) then the repetition of the outcome is in doubt. The degree of certainty that the outcome will reoccur decreases.

Self-concept. The stability dimension also influences the maintenance of an individual's self-concept. Perhaps in an attempt to save face, unfavorable results that are unexpected by individuals are usually attributed to unstable causes. Therefore their level of self-concept is not altered. An example may be an individual who has a high level of self-concept of ability in mathematics. This produces a high degree of certainty of probable future success on math tests and assignments. If a failure were to occur, it would be unexpected and attributed to an unstable cause. The student then maintains a high expectancy level of future success. If a success occurs on a math test, it merely reaffirms the individual's high self regard and high certainty level of future success. The converse also holds true. Students with low self-concepts of ability in mathematics predict they will fail. When they do, it reaffirms their notions of low ability in math and supports their low levels of self-concept. Success outcomes would be attributed to unstable causes since such results were unexpected. Therefore students retain their certainty that they will fail in the future.

Behavior extinction. Resistance to the extinction of a behavior and resistance to achievement change are related to the stability of a perceived cause. Extinction of a behavior occurs during periods when the behavior is no longer reinforced. When individuals consider the cause of the nonreinforcement to be unstable, the extinction rate decreases. The individual still expects a reward since the nonreinforcement cause is unstable. The opposite effect (increased extinction rate) occurs if nonreinforcement is attributed to stable causes (Rest, 1976). It has been experimentally shown that random reinforcement schedules elicit unstable causal attributions (Weiner, 1971). These intermittent reinforcement schedules increase an individual's resitance to the extinction of an associated behavior (Weiner, 1979).

Reinforcement and extinction. Past researchers (Jenkins and Stanley, 1950; Ferster and Skinner, 1957; Skinner, 1968) have reported findings that concur with the idea of intermittent reinforcement decreasing the extinction rate of a behavior. Radical empirists attribute the phenomenon to appropriately scheduled reinforcement contingencies. Cognitions of the individual do not produce an effect. Cognitive-field researchers (Weiner, 1979) emphasize the idea that the cognitive processes (causal attribution perceived along a causal dimension) within the individual adds an important component to the S-R relationship. The explanation of extinction certainly illustrates the differences between the behaviorist's S-R paradigm and cognitive field psychologists (specifically Weiner) S-C-R paradigm.

CAL application. How do these two sets of ideas apply to the computer activity example previously mentioned? Let us say we have two sets of students. One group receives 100% reinforcement for the responses they make on the computer while completing a mathematic computation exercise. The other group receives intermittent reinforcement randomly administered according to a schedule of one response reinforced in four responses emitted. Let us also say that all students are doing quite well. That is, they appear to have mastered the task at a 90% level of success. The groups of students are exposed to the computer activity on ten occasions.

Theoretical viewpoints and predictions. Both Skinner (1957) and Weiner (1979) would predict that students in the 100% reinforcement group would do more questions than students in the other group. Both theorists would account for this phenomenon by the differences of the reinforcement schedules. When reinforcement was discontinued, again the predictions of resulting behavior made by the two schools of thought would mirror each other. Students' performances (questions attempted) would drop more for the 100% reinforcement group than for the intermittent reinforcement group. Skinner (1957, 1968) would explain that the exposure of the students to intermittent reinforcement enables them to continue emitting behavior under conditions of nonreinforcement because they have been conditioned not to expect rewards on every response. Weiner (1979) would argue that the causal attributions perceived by those students who were reinforced 100% of the time were of a stable nature. Conversely, the intermittently reinforced students perceived unstable causal attributions. Unstable causal attributions result in prolonged performance during an extinction period since the individual's expectancy of reward remains unchanged. The student in the 100% reinforcement group changes his expectancy of reward quickly. Once they were always rewarded and now they never receive a reward. Therefore the behavior (performance) ceases. One theory sees resistance to extinction as an artifact of conditioning, the other views it as a combination of conditioning and human cognition.

Courseware appropriateness. What does this tell us about CAL practices? Regardless of which theory is actually followed the resistance to extinction phenomenon is linked to reinforcement scheduling. If a teacher wants to incorporate CAL programs into a mathematics curriculum, care must be taken to choose courseware that is appropriate. Indeed a teacher would want a skill or performance level developed with CAL assistance to be continued in the classroom. The classroom environment cannot provide the student with a 100% reinforcement schedule. The courseware selected should be an intermittent reinforcement schedule to prevent performance loss due to extinction resulting from prolonged periods of nonreinforcement in the classroom. Are designers of courseware aware of this phenomena? Are CAL designers concerned only with rapid acquisition of skills? Is courseware for middle year mathematics students adequate?

Expectancy of success and extinction. If an individual must experience a great deal of exertion to attain a goal or reward, the cause of the outcome is very likely to be attributed to effort. Since effort is an unstable causal attribution, the high degree of expectancy of achieving the reward in the future, even when the goal was not attained, remains unchanged. The student's behavior is prolonged since the extinction rate is lowered. However, repeated failure will develop a shift in causal ascriptions. Attributions will now center on the individual's ability or task difficulty both of which are stable causes. The expectancy of future success is now reduced and the rate of behavior extinction increases (refer to Figure 3).

Locus Dimension

Affects. Specific studies were initiated to determine the relationships between attribution and affect. Weiner, Russell and Lerman (1978, 1979) discovered two categories of affects. Outcome-dependent, attribution-independent affects are broad positive or negative reactions to success or failure regardless of the causal attribution made by the individual as to why the outcome occurred. Successes evoke happiness, feelings of pleasure, satisfaction and goodness. Failures produce uncheerfulness, displeasure and a feeling of being upset. It was also reported that outcome dependent, attribution-independent affects are most intensely experienced.

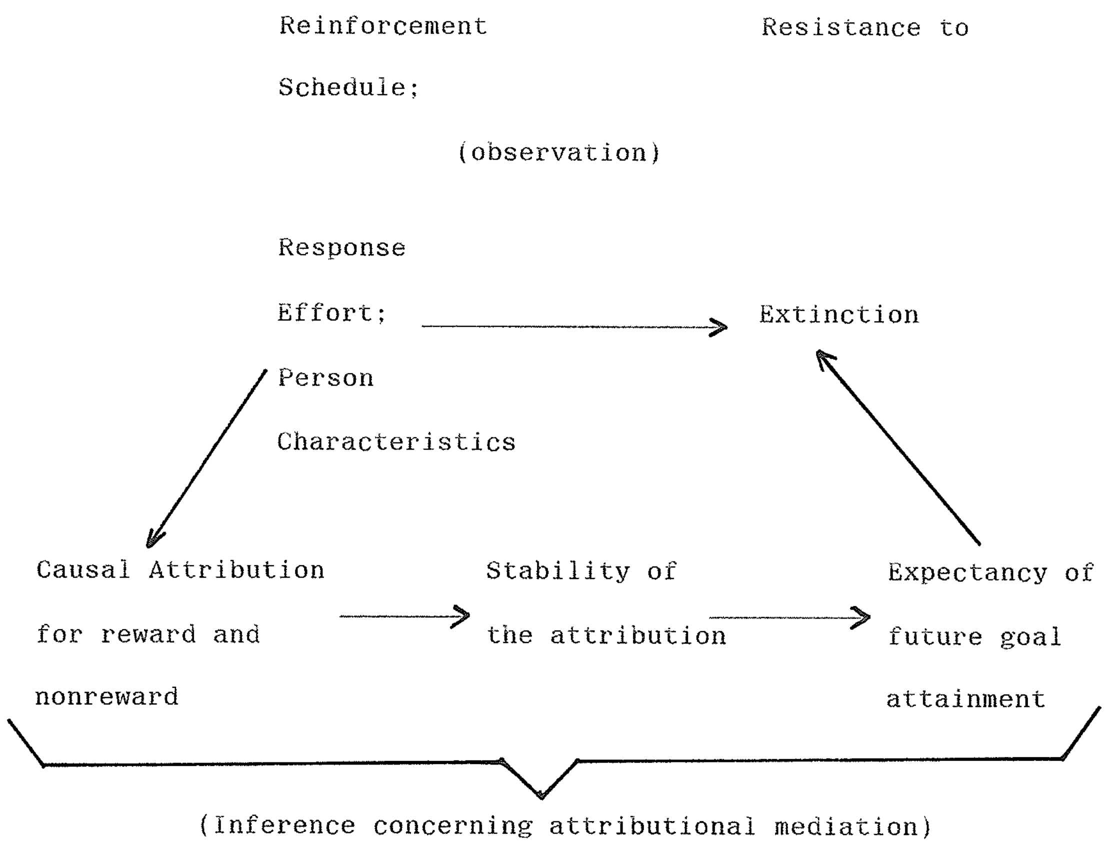
The second category, attribution-dependent affects were experienced by individuals in accordance to the causal attribution they had made regarding the associated outcome (refer to Table 3).

Control Dimension

The control dimension refers to interpersonal judgments. It centres upon inferences made by individuals about the actions of

Figure 3

Effect of Causal Attribution on Behavior Extinction



(The observed traits of the environment and the individual trigger the internal mediation process which can only be infered. The result is an observed extinction rate.) From "A theory of motivation for some classroom experiences" by B. Weiner, 1979, Journal of Educational Psychology, 71, p. 12. Copyright 1979 by the American Psychological Association, Inc.

Table 3

Attribution Dependent Affects

Causal Attribution	Affects	
	Success	Failure
Ability	Competence	Incompetence
	Confidence	
Unstable Effort	Activation	Guilt
	Augmentation	Shame
Stable Effort	Relaxation	Guilt/Shame
Personality	Self	Resignation
	Enhancement	
Others	Gratitude	Aggression
Luck	Surprise	Surprise

From "The cognition process in achievement-related contexts" by B. Weiner, D. Russell and D. Lerman, 1979, Journal of Personality and Social Psychology, 37, p. 1212.

others. The individual's belief about another's responsibility for success or failure influences the individual's reaction toward that person. The associated affects are related to the individual's perception of the other person.

Summary

Weiner (1985) expanded the attribution theory by incorporating more affects within the framework. The study at hand is not intended to test for the existence of affects. This study is particularly interested in: 1) a student's rate of persistence at a task due to the antecedents associated to reinforcement schedules, 2) the student's causal ascriptions for their achievement outcomes, 3) the testing of the Attributional Theory's stated relationship between the expectancy of success and the stability of the causal attribution, and 4) the testing of the extinction rates of behaviors as related to the stability of the causal attributions. Hence the concentration and elaboration of the causal stability dimension by this thesis. Information pertaining to the Locus and Control dimension is presented to provide the reader with an overview of the entire attributional theory. The model of Weiner's theory presented in his 1979 article best applies to the study at hand (refer to Table 4).

Table 4

Partial Representation of an Attributional Theory of Motivation

Antcedant Conditions →	Perceived Causes →	Causal Dimensions →	Primary Effects →	Other Consequences (Behaviors)
Specific Cues	Ability	Stability →	Expectancy change	Performance intensity
Individual differences	Effort (typical) and immediate)	Locus →	Esteem related affects	Persistance
Reinforcement types	Others (students), family, teacher)	Control →	Interpersonal judgements	Choice
Reinforcement schedules	Motivation (attention, interest)			Etc.
Etc.				

From "A theory of motivation for some classroom experiences" by B. Weiner, 1979, Journal of Educational Psychology, 71, p. 18.

Computer Related Literature

Introduction

Previous CAL research. Since the introduction of computers into the field of education, there have been a myriad of studies conducted on the characteristics of the "new" instructional technology. The vast majority of past studies have compared CAL related student learning gains to student learning gains obtained through traditional teaching methodologies. Little work has been conducted on the purely motivational characteristics of CAL related activities.

Future research. Reinking (1985) states that the primary goal of CAL related research should probably be the identifying of significant variables in an effort to build theoretical perspectives. All significant variables concerning CAL software design have not yet been sufficiently examined. This thesis is an attempt to assist in filling that void.

Section organization. To provide the reader with a clear impression of the CAL related field, this section will include a brief rationale for the use of CAL in education. Also presented will be empirical evidence illustrating student learning gains, the characteristics of feedback and reinforcement and their effect on learning behavior, the ideas of overlearning and automaticity and finally a look at research aimed at motivation related aspects of CAL.

Rationale for Computer Use in Education

Individual differences. Educators have always been faced with the individual differences of their students. Such a situation is no more noticeable than at the middle years level (the subjects of this study). Piaget (1970) indicated that youths in the middle years are moving from concrete to formal operations. Individuals within one classroom grouping will be scattered along that continuum. Osborne, (1984) adds that the students at that level can display a wide range of personal needs, all of which require satisfaction. Individual instruction at that educational level has been regarded as being essential (Osborne, 1984; Wiles and Bondi, 1981). Effective CAL practices can adequately deal with the individual differences of students since the learning is done at the individual student's own rate of learning (Young, 1982; Kulik, 1984; Shuy, 1981; Smith, 1986; Ohlsson, 1985).

Immediate feedback. Proponents of CAL have emphasized that immediate feedback is one of the main features of the technology (Lysakowski, 1981). Of course, this notion has yet to be fully examined. Lai, (1984) adds that any teaching method can be greatly improved by providing the condition of immediate feedback. Immediate feedback has been regarded as being a "motivating" condition in CAL (Mosely, 1984; Donhardt, 1984; Lysakowski, 1981; Day, 1982). Others, (McKenzie, 1987; Camier, 1983) refer to the condition of active learner involvement as being motivating. CAL activities do seem to be motivating regardless of the characteristic proposed. Mastery learning techniques considered to be motivational have developed higher student learning gains and greater information retention rates than traditional teaching methods (Travers, 1982). Mastery learning techniques have been enhanced using CAL practices (Donhardt, 1984).

Decreased learning time. Another reason used to support CAL practices in schools is that of decreased learning time required for the acquisition of knowledge (DeBonis, 1982; Dugdale, 1980; Nelson, 1979; Cortez, 1984; Kulik, 1983; Zsiray, 1984). Along with this faster learning rate, these researchers have reported attitude changes in the students exposed to CAL. Students displayed positive school related attitudes even when computer exposure was limited (DeBonis, 1982; Searles, 1980; Kulik, 1983; Mosley, 1984; Lai, 1984).

Summation. Results of the studies cited in this paper indicate that there are advantages to CAL practices in schools. It is assumed that this teaching methodology will continue to be used in schools. It is hoped that the technology will be used appropriately.

Learning Gains Related to CAL

Results of research. It appears that early studies investigating learning gains in mathematics courses revealed significant results. That is, students using CAL methods in their mathematics class learned more than students using traditional teaching methods (Cranford, 1976; Romero, 1979; Modisett, 1980). More recent studies dealing with this question regarding students from elementary school (Anand and Ross, 1987) to middle school (Dalton, 1985) have reported no statistically significant differences between the two learning conditions. Perhaps this is due to improved research methodologies or to the increased familiarity of subjects with the once novel computer. Nevertheless, studies examining specially developed computer environments have indicated significant student learning gains in mathematics. The entire Periwinkle Elementary School in Oregon received mathematics instruction via the WICAT System 300. In that school, significant learning gains were experienced by grade 1, 2 and 3 students (Stroneburg, 1985). A middle school placed all of its 6th grade students into a CAL mathematic immersion program. Significant learning increases were reported but the increases were not to the magnitude that the researchers and the school officials had expected (Ferrell, 1985). Conversely, Archambeaut, (1986) and Baron, (1986) have reported that the amount of computer interaction time by students on mathematics programs is positively related to mathematic achievement. Students spending more time on the computer will do better than students having limited CAL exposure. Yet a full time (immersion) project's results were not so definite. Research results in the

CAL field, when taken together, seem to be inconclusive.

CAL characteristics. Studies have identified specific characteristics of CAL that appear to maximize learning gains for students. One such characteristic concerns the learners themselves. Lower ability students produce greater gains on CAL administered instruction than on programs using traditional teaching methods (Walker and Azumi, 1985; Darling, 1986; Suppes, 1982). The second characteristic deals with the software used in the instruction. Studies show that increased gains are achieved by using drill and practice routines rather than tutorials (Charp, 1981; Walker and Azumi, 1985). Apparently the less sophisticated software format is more effective at producing desired learning gains (Kulik, 1983). Generally speaking, CAL programs do no worse, occasionally better, than traditional teaching methods at producing student learning gains in mathematics.

Reinforcement and Feedback

Differentiation. At times it seems difficult to differentiate between the two entities of reinforcement and feedback. Travers (1982) explains that feedback designed strictly to provide information also carries with it an incentive value similar to that associated with reinforcement. Walker and Hess (1984) define feedback as any compound statement that follows a student's response. They argue that feedback statements should not be regarded as a reinforcing stimulus. The definition of reinforcement and feedback appears to be determined by the operational definitions of individual studies.

Beneficial feedback. There are characteristics of feedback statements that produce increased desired affects. Studies have shown that praise is an effective reinforcer that enhances academic performance (Dalton and Hannafin, 1985; Heller and White, 1975; Lipe and Jung, 1971; Meyer, Bachmann, Bierman, Hempelmann, Ploger and Spillar, 1979; Brophy, 1981). Other studies support this notion and add that praise increases a student's motivational level (Mosley, 1984; Lewis and Cooney, 1986). Knowledge of correct results also tends to increase performance rates (Litz, 1973; Jaeger, 1985; Schimmel, 1983; Reiser and Gague, 1982). Jaeger goes on to add that students were more interested in the computer feedback containing correct results than they were toward the once assumed to be highly motivating sounds and colour capabilities of the program. Sound and colour were literally ignored by the students in Jaeger's study.

Reinforcement scheduling. Skinner (1954, 1968) purports that students acquiring a new skill must be reinforced for every correct response they make. Skinner further notes that reinforcement must be administered immediately following a response. Dalton and Hannafin (1985) contend that the key advantage of CAL is the control the educator has over the scheduling of reinforcement. Various types of feedback can be administered to tailor fit the needs of individual students. Skinner (1957, 1968) would concur with the idea that reinforcement scheduling and contingencies must be managed if their full effectiveness is to be utilized. CAL practices enable educators to do just that.

Overlearning

Automaticity. Overlearning is a technique in teaching where the learner extensively practices a task to the point where it becomes second nature. Case (1980) refers to this process as Automization. Case states that the human mind has a limited amount of working memory. If students have not overlearned routine operations such as the multiplication tables, much of their working memory will be engaged in completing the routine task when faced with a complicated problem. Since automaticity of the basic mathematical operation has not occurred, the student will require more time to complete the complicated task. Case states that the curriculum must provide students with massive opportunities to practice basic operations. Gagne (1982), and Lesgold (1982) concur with Case. They go on to say that if the sub processes involved in complex skills (reading, problem solving) do not become automatic to the learner, such processes cannot be successfully undertaken. One method of providing teachers with practice sessions in mathematic computations is CAL drill and practice programs. This notion has been supported by studies concerned with increased reading fluency with learning disabled students (Torgesen, 1986).

Motivation

Research concerns. A problem with CAL research is the manner in which studies report motivational results of computer related activities. Much of the reporting has been merely statements such as "reinforcement increases motivation" (Swenson and Anderson, 1982) or "the computer itself seemed to be a strongly motivational factor" (Mosley, 1984). Such statements tell educators and CAL designers very little.

Studies on motivation. Some earlier studies designed specifically to measure changes in students' levels of motivation have been based on motivation theories but they did not include CAL activities. Such studies tested hypotheses regarding self reinforcement and intrinsic motivation and how these items can be affected by external reward for performance (Deci, 1973; Sushinsky, 1976; Williams, 1979). Recent studies in motivation have incorporated computers into their designs. The primary measure of motivation in these studies was performance. Hessemer-Stegemann (1986) regarded the number of problems attempted by students as indicating the students motivational level. Seymour and Sullivan (1986) considered the amount of student time used to perform a task on a computer as an index of student motivation. Both studies were based on separate theories of motivation. The manipulation was basically the same, computer tasks as opposed to pen and pencil tasks. Results did furnish some evidence that computers are motivational agents in classrooms.

A study by Lewis and Cooney (1986) manipulated the types of feedback provided to students by CAL tasks. The researchers were looking at student causal ascription for success as related to their feedback condition. Needless to say, research efforts regarding CAL and motivation have become more sophisticated and therefore more meaningful.

Computer Related Rationale for the Present Study

Computer assisted instruction phenomenon. The Computer Assisted Instruction (CAI) Phenomenon refers to increased amounts of material that can be learned in less time when it is delivered by CAL methods as opposed to traditional methods. Students instructed by computers learn the same amount of material as students who are instructed traditionally but at a much faster rate. Equal learning in less time is called the CAI phenomenon. This phenomenon can be explained by the "Time-on-Task" Hypothesis (can increase in student time spent on the learning task results in accelerated learning) and a construct labelled "Academic Learning Time" (Bright, 1983).

Time related success. Each student has a specified amount of time available for instruction of a particular academic subject.

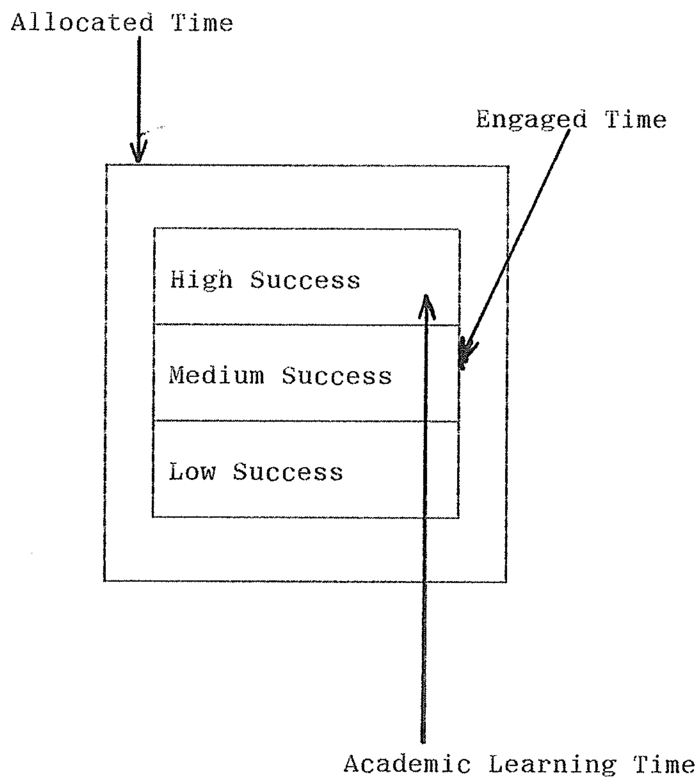
This is called Allocated Time. Within the allocated time is a smaller block of time which represents the actual time a student spends attending to instruction. This block is referred to as Engaged Time. The surplus of Allocated Time accounts for non attentive student behaviors such as daydreaming and pencil sharpening. Engaged Time is further categorized into the three classifications of High Success, Medium Success and Low Success. Success refers to the achievement of the student. High Success constitutes few errors being made by the student whereas Low Success refers to a high rate of incorrect responses. The High Success classification is also referred to as Academic Learning Time (refer to Figure 4).

Research focus. Understanding a potential cause for "equal academic gains in less time" permits researchers to focus upon ways to increase CAL's efficiency and effectiveness. Research literature should be directed toward uncovering techniques that increase the amount of student engaged time at the high success level (Bright, 1983).

Software concerns. The use of computers in educational settings has increased dramatically over the past ten years. The result has been a proliferation of software that has come onto the market. Much of this software was developed according to a simplistic interpretation of behaviorism (Rotheray, Sewell and Morton, 1986). Indeed, a large portion of the software used in

Figure 4

Academic Learning Time



(Aademic learning time in relation to time allocated to an academic subject and to student success levels.) From "Explaining the efficiency of computer assisted instruction" by G. W. Bright, 1983, AEDS Journal, 16, p. 147. Copyright 1983 by Association of Educational Data Systems.

CAL practices today are examples of programmed instruction from ten years ago (Nishikawa, 1985). Software designers must be aware of what computers can do and design programs that are appropriate for a specifically targeted population of students (Kurshan and Williams, 1985).

Evaluation criteria. Software is evaluated constantly by such groups as Educational Products Informative Exchange (EPIE), Northwest Regional Educational Laboratory (MicroSIFT) and Alberta Education's Microcomputer-Based Courseware Evaluation (Infotech Resource Centre, 1987). Constant review and evaluation does not necessarily translate into meaningful evaluation. The criteria used by reviewers in determining whether the feedback procedures used by a particular program are appropriate or inadequate is not known. Indeed it is the thrust of this thesis that the components of such a design criteria regarding appropriate feedback procedures has yet to be fully investigated.

Call for research. An essential practice of researchers is the making of recommendations for future research activities. Some such recommendations have already been mentioned in this paper. Other recommendations refer to feedback procedures.

Merrill (1985) reports that there is very little current data that has been collected on appropriate forms and uses of feedback. He recommends that work pertaining to feedback procedures in relation to concept learning must be carried out. Geibprasert

(1986) concurs with this point. He states CAL related research efforts must be conducted in areas of feedback strategies for improving student learning rates specifically in mathematics. More generally stated by Jaeger (1985), continued research should be aimed at identifying the most efficient feedback strategies in operant style computer assisted instruction.

It seems apparent that researchers believe there are basic CAL principles that require further investigation. As Weiner (1986) puts it, research efforts regarding the instructional uses of computers is abundant, however an equal amount of work must be carried out that is designed to deal with more fundamental CAL questions that have not yet been satisfactorily answered.

Summary. As indicated, more research is required on feedback procedures in CAL activities. Indeed, more research is required concerning the application of motivation theory principles in an actual field environment. Much of the past work (Weiner, 1971; 1978) done with motivation theories has been done using tasks that are contrived and settings that are not naturalistic. Little has been done to test the theoretical principles of motivation theories in a natural setting with actual academic tasks. If a relationship between motivation and CAL feedback scheduling can be uncovered, such data may lead to software design principles that will increase the efficiency and effectiveness of all courseware.

CAL in mathematics. In the field of mathematics, the theoretical position of automaticity appears to play a crucial role. This is indeed the case regarding the learning and practicing of basic operations. The drill and practice design of CAL courseware has been shown to be the most appropriate format for the rehearsal of basic operations. However, as previously mentioned, basic principles regarding feedback scheduling have yet to be fully investigated.

Present study's focus. The aim of the present study is to furnish data that will provide evidence for a courseware design principle that should be used when designing drill and practice format programs in mathematics directed at the middle years student. Feedback scheduling may be an integral part of the motivational process within students. Students will require high levels of motivation to continue performing tasks designed to create overlearning of basic mathematics operations. If we can keep students motivated, their time-on-task behavior will increase. This will lead to higher levels of performance and eventually higher levels of achievement. Can the motivation level of students be influenced by feedback schedules in CAL programs? Is there only one type of feedback appropriate of all middle years students? Can Weiner's Attribution Theory be used to explain the influence of changing feedback schedules? Answers to these questions will provide evidence on which future knowledge can be developed and applied. Answers to these questions are required by educators, by courseware developers, by courseware evaluators and by theorists.

Hypotheses of the Study

1) Performance levels (measured by the number of questions attempted) will be greater for subjects in 100% and 25% feedback treatment groups than in the 0% feedback group. Subjects in the 25% feedback group will experience the greatest levels of performance (25% > 100% > 0%).

2) There will be no differences in the average achievement levels (number of questions correctly answered) of the three feedback groups (25% = 100% = 0%).

3) The performance rate of subjects in the 25% feedback group will be more resistant to extinction than that of subjects in the 100% feedback group. Extinction will not affect the performance rates of subjects in the 0% feedback group (25% > 100%).

4) Subjects in the 25% feedback group will attribute their performance to unstable causes.

5) Subjects in the 100% feedback group will attribute their performance to stable causes.

6) Subjects in the 0% feedback group will attribute their performance to stable causes.

7) Subjects in the 100% feedback group will have a higher

degree of certainty regarding their predictions for future performance than that of the subjects in the 25% feedback group (100% > 25%).

8) Subjects in the 0% feedback group will have a higher degree of certainty regarding their predictions of future performance than that of the subjects in the 25% feedback group (0% > 25%).

9) Locus of Control will not have a significant relationship with any of the dependent variables in this study.

CHAPTER THREE

Method

Experimental Design of the Study

The present investigation utilized a quasi-experimental design. Due to the fact that the study was conducted in a natural school setting, random subject selection was not possible. Convenience sampling of one intact classroom grouping was used. The experimental design employed in the study was a time series design which included a control group. The alpha level for the study was set at 0.05.

Independent variables. The independent variables of this study refer to the computer administered feedback conditions. The three independent variable schedules are:

1) 100% immediate feedback (group one).

2) 25% random, immediate feedback (group two).

3) 0% feedback (group three).

Treatment group one will receive feedback statements after every response they make. The feedback in this 100% schedule is immediate; directly after the student's response.

Treatment group two will receive feedback statements on the average of one student response receiving feedback for every four responses entered into the computer. Responses receiving feedback will be randomly selected on a "one in four" bases. Feedback, when administered, will directly follow the student's response (immediate feedback).

Treatment group three comprised the control group component for this study. Subjects in this group will receive no feedback (0%) following their response inputs.

Dependent variables. Effects of the influence of a particular independent variable will be measured on four dependent variables. These variables are:

1) Performance rates.

2) Achievement levels.

3) Certainty ratings.

4) Stability rankings of a cause.

Performance rates refer to how many computation problems administered by a computer a subject can complete (successfully or unsuccessfully) in a ten minute time period. Performance rate was assumed to be an overt indicator of a subject's motivational level.

Achievement levels refer to the percentage of questions a subject successfully answered from all the questions attempted during the ten minute computer administered task. Achievement levels were assumed to be an overt indicator of a subject's decimal computation skill level.

Certainty ratings was a variable measuring one of the theoretical notions of Weiner. Certainty refers to the degree to which a subject believes that the present academic success (or lack of success) being experienced will be repeated in the future. Certainty ratings were measured during four reporting sessions throughout the course of the experiment by using a likert-type scale. The scale measures from a low of one point (low level of certainty) to a high of ten points (high level of certainty).

Stability ranking refers to the degree of stability a subject perceives a causal attribution has in regards to that subject's present academic success level. Causal attributions are made by the individual subject. This variable also refers to the testing of one aspect of Weiner's theory. Causal stability was assessed by the use of the Causal Dimension Scale (Russell, 1982). The stability component of Russell's scale measures from a low of three points (perceived unstable cause) to a high of twenty-seven points (perceived stable causes).

Sample

The sample for this study was twenty-one (21) grade eight students, fourteen (14) males and seven (7) females. All subjects attended an urban school which followed a middle years philosophy. The socio-economic status of the community serviced by the school was predominantly middle class. All subjects were from the same home room grouping which meant they all received their mathematics instruction from the same teacher (not the experimenter). Rankings on the Canadian Test of Basic Skills (CTBS) written by the subjects in April of 1987 indicated a range from a low of 1

%tile to a high of 62 %tile for the total mathematics score (percentiles are based on national norms). The average CTBS ranking was 22.3 %tile. The scores indicate that the group's skills as a whole were somewhat below that of an average student. The ages of the subjects range from 12 years, 5 months to 16 years, 1 month with an average age of 14 years, 6 months. Eleven (11) students had repeated one previous grade and two (2) students had repeated two previous grades. None of the subjects were repeating grade eight.

Limitations of the Sample

Size. Size is the first limitation of the sample. Larger samples tend to better represent a population.

Gender. A second limitation of the sample is the uneven number of male and female subjects (females being very few in number). This condition makes it very difficult to investigate gender related characteristics.

Subject's skill level. The third limitation of the sample is in regards to the subjects' lower skill levels. Lower level subjects in any experimental manipulation tend to show greater improvement (results) than the other subjects. Since this study is not entirely based on achievement gains, this limitation may have few confounding affects. Nevertheless, this situation must be kept in mind.

Keyboard skills. A fourth possible limitation of the sample concerns keyboard skills. As subjects become more proficient at using the microcomputer's keyboard, their performance rates will increase. It is assumed that this situation will be minimized due to the limited number of computer sessions.

Single class grouping. The last limitation of the sample concerns the fact that all subjects are in the same home room grouping. Such close contact may result in subjects from one experimental treatment group gaining knowledge about the different feedback schedules used in another experimental treatment group. The close proximity of subjects from different treatment cells may cause increased difficulty in maintaining an aspect of control during the experiment.

Procedure

Pre-experimental tasks. Subjects were asked to complete the Intellectual Achievement Responsibility (IAR) Questionnaire adapted from Crandall, Katkovsky and Crandall, 1965; (refer to Appendix F). The questionnaire was administered to all subjects at the same time during a Health period. The Health unit being taken at that time was the Social-Emotional Well Being Unit.

Determination of treatment groups. Subjects were given a pre-test on decimal calculations. The pre-test questions were generated by the computer program utilized in the study (refer to Appendix D). The measure was a paper-pencil test administered to all subjects during a mathematics class. The mathematics unit being taken at the time was Decimals.

Pre-test scores were used to rank the subjects from 1 to 21 according to achievement. The rank order was then divided into seven sets of triplets. Members in each triplet were randomly assigned to one of the three experimental cells (independent variables): one hundred percent (100%) feedback, twenty-five percent (25%) random feedback and no feedback (control). The toss of a die was used to determine into which treatment cell the members of the triplet would be placed. Refer to Table 5 for the final configuration.

Computer training session. All subjects were given a training session in the computer room which housed the seven Apple IIe microcomputers used to administer the program in this study. Items addressed during the training session were:

1) How to make an input (type in the numbers and press return).

2) How to change an answer once typed onto the screen (press the delete key once for each digit on the screen then re-type the correct response).

3) How to advance to the next question (press the space bar).

Subjects were also told that scrap paper was to be used to work out the calculation for each problem prior to typing the response

Table 5

Treatment Group Assignment

Pre-test Achievement Ranking	Triplet	Assigned Treatment Group
1 2 3	1	25% 100% 0%
4 5 6	2	25% 100% 0%
7 8 9	3	25% 0% 100%
10 11 12	4	100% 25% 0%
13 14 15	5	0% 25% 100%
16 17 18	6	25% 100% 0%
19 20 21	7	25% 0% 100%

Note. Percentage values refer to feedback schedules.

into the computer.

Subjects from each experimental group were assigned a specific computer.

Pre-experimental trial preparations. The microcomputers were loaded with the appropriate program (treatment condition) and the names of the subjects were entered into the machines prior to the subjects' entry to the computer room. This was done by an adult supervisor in the room at the time of the trial.

The computer program. The program used for this study was a drill and practice routine using questions consisting of decimal numbers. The program randomly generated the questions therefore the questions presented to students from trial to trial were different.

The program had two skill levels. The number of digits in the questions were determined by the criteria set by the mathematics curriculum for grade eight.

Major characteristics of the program are as follows:

1) Large font (size of numbers on the screen).

2) Ten (10) minutes (plus or minus fifteen seconds) time limit. The Apple IIe does not have an internal clock. The time limit of the program was determined by an external loop incorporated within the program itself. This accounted for the plus/minus time factor.

3) 100% feedback schedule: the correctiveness of each

student response was indicated on the screen immediately after a response was entered into the machine. Feedback statements included a simple statement of praise (correct response) or an indication that an error had been made along with the correct answer (incorrect response). Subjects' first names were incorporated into the statements. Students received a summary of their efforts at the end of the 10 minute run; number of questions attempted, number of questions correctly answered and a percentage).

4) 25% feedback schedule: feedback statements in this schedule were the same as in the 100% feedback schedule. The computer program randomly administered feedback according to a one feedback statement to four response ratio. Students received the summary of their performance at the end of the program.

5) 0% feedback schedule: the students received no feedback statements nor did they receive the summary of performance at the end of the program. Summaries were retrieved from the program at the end of each trial by using a code number entered by an adult supervisor. Students were told their performance results the following school day prior to beginning their next computer trial.

6) Questions in the program included the three basic operations of addition, subtraction and multiplication. Division was excluded from the program due to the extreme weakness of some students in regards to the division process. The experimenter did

not want student performance to be determined by student division expertise. (Refer to Appendix B for a listing and Appendix C for sample questions and feedback statements of the program.)

Establishing performance baseline. Each subject completed three separate computer trials. Each subject used the 0% feedback schedule to establish a performance baseline. Subjects reported to the computer room with the members of their treatment group. The three groups of subjects completed one trial within a single 40 minute mathematics period. The normal mathematics period of forty minutes was divided into three separate time slot sessions; session 1 - 5 minutes to 15 minutes, session 2 - 16 minutes to 26 minutes, session 3 - 27 minutes to 37 minutes. Treatment groups were randomly scheduled into one of the three time slots daily. While subjects were not on the computer, they remained in their regular math room partaking in regular classroom activities with their math teacher. Students absent for a computer session would complete it on the next school day. This was the procedure followed for each computer trial session throughout the experiment.

Performance established by treatment conditions. Each treatment group completed 10 computer trials under the influence of the feedback schedule assigned to that particular group. Each subject's performance was recorded by the adult supervisor in the computer room.

Subject predictions and causal attribution statements. On trial periods one (1), six (6), extinction trial 1 and at the conclusion of the extinction trials subjects were required to individually complete the following tasks:

1) Subjects were asked to predict their performance and achievement for the upcoming trial.

2) Subjects were asked to mark on a likert-type scale how certain they were that their predictions would come true.

3) Subjects were asked to make a causal ascription for the performance they had experienced up to that point in the experiment. The subjects then completed the Causal Dimension Scale (adapted from Russell, 1982) to assess what level of stability the subject regarded the causal ascription. The teacher in charge could assist the students in completing the form when necessary. Assistance given was the simplification of the language used in the question and elaboration of what the likert scale represented. Examples of causes were not provided to the subjects. All responses to the tasks were done in writing (see Appendix G).

Extinction trials. Following the same procedure as all previous computer trials, subjects completed three final computer trials. Subjects during extinction trials used the feedback schedule of 0%. Results of performance were recorded by the adult supervisor. Table 6 illustrates the arrangement of computer

Table 6

Treatment Group[a] Computer Session Schedule

Period	Trials															
Session	Baseline			Experimental Manipulation										Extinction		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	3	1	2	2	1	1	2	2	2	2	1	2	1	1	2	2
2	2	2	1	3	2	2	1	2	1	3	3	1	2	3	2	1
3	1	3	2	1	3	3	2	1	2	1	2	3	3	2	1	3

[a]Group 1 100% feedback

Group 2 25% feedback

Group 3 0% feedback

Note. Regular class periods were split into three equal time portions corresponding to the session numbers above. Body of the table consists of group numbers.

sessions over the 16 trial period.

Post-test. A paper and pencil post-test comprised of questions generated by the computer program was administered to the subjects the school day following the extinction trials. The test was administered in the regular math classroom under the same conditions for the pre-test (refer to Appendix E).

Statistical Methods Employed

Time series. As previously indicated, the experimental design of the present study consisted of a time series format. The alpha (x) level for this study was set at 0.05.

Nonparametric procedures. The Friedman Two-Way Analysis of Variance by Ranks (Siegel, 1956) was the statistical method used to test for differences between the three independent variable groupings (100% feedback, 25% feedback and 0% feedback) in regards to the following dependent variables:

1) Performance (hypothesis 1).

2) Achievement (hypothesis 2).

3) Resistance to Extinction (hypothesis 3).

4) Causal Dimension Subscales (hypotheses 4, 5 and 6).

5) Certainty ratings (hypotheses 7 and 8).

Wilcoxon matched-pairs signed-ranks tests (Siegel, 1956) were conducted on each feedback group's Causal Dimension Subscales (hypotheses 7 and 8) for each of the four reporting periods. Pre-test and post-tests results were also compared using this test.

The Spearman Rank Correlation Coefficient (Hopkins and Glass, 1978) was used to compare the subjects' scores on the Intellectual Achievement Responsibility (IAR) Questionnaire with the scores of all other dependent variables (hypothesis 9). The test was also used to compare the results of the pre-test and post-test.

Criteria for educational significance. In some instances, statistical significance is not crucial. Results may be significant in terms of what they imply for educational practices. Educational significance in this study is determined by the following criteria:

1) An independent variable produced an overall pattern of increased achievement levels for the members of a particular treatment group.

2) An independent variable produced an overall pattern of increased performance rates for the members of a particular treatment group.

3) An independent variable produced an overall pattern in a treatment group's reported certainty level and causal stability ratings.

Such established patterns would hold implications for future educational practices in regards to feedback scheduling and CAL courseware design principles. Results of the experiment, descriptive statistics and nonparametric statistics are presented in chapter 4. Information has been presented in both forms of tables and graphs. Interpretation and explanations for the results are offered in chapter 5.

CHAPTER FOUR

Results

The raw data generated in this study have been analysized using descriptive statistical and nonparametric statistical methods. Results have been reported according to the following categories:

1) Performance.
2) Achievement.
3) Grouped Data.
4) Certainty Scale.
5) Causal Dimension Scale.
6) Pre-test and Post-test.
7) Intellectual Achievement Responsibility Questionnaire.
8) Post hoc Analysis.

Results have been presented by group in table and figure form which augment the text. Subjects in group one were under the influence of the 100% immediate feedback condition. Group two refers to those subjects influenced by the 25% random, immediate feedback condition. The control group was group three, the 0% feedback condition. Raw data tables are located in Appendix A.

Performance

Table 7 presents a descriptive look at the performance results. The means and standard deviations associated to each of the three treatment groups are reported for each computer trial of

Table 7

Descriptive Statistics: Means and Standard Deviations for Performance Data

Trial	Group 1		Group 2		Group 3	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
1	42.857	9.771	41.143	10.319	36.0	7.528
2	60.0	11.343	53.143	16.293	46.857	12.362
3	66.286	9.160	58.714	19.414	55.143	11.335
4	60.0	15.055	53.714	15.130	55.174	16.997
5	63.714	26.266	64.429	16.642	56.429	21.839
6	72.857	24.224	61.714	14.750	57.429	19.747
7	77.429	28.071	66.429	11.674	60.286	24.534
8	79.714	29.313	70.857	15.540	65.0	25.456
9	82.286	29.432	76.857	19.912	66.0	26.665
10	82.571	29.131	67.714	15.564	65.857	26.454
11	77.0	30.419	72.0	19.218	65.286	30.220
12	89.286	33.959	84.857	18.470	68.143	30.515
13	94.143	33.314	86.429	22.382	65.143	32.158
14	91.571	29.376	85.286	24.060	66.0	33.461
15	97.0	28.419	87.286	23.329	64.714	32.602
16	87.714	33.817	76.714	18.865	69.286	35.785

the experiment. Generally speaking, the means and standard deviations for each group increased throughout the sequence of trials. Figure 5 graphically represents the information regarding group means per trial. Subjects in group 1 (100% feedback) exhibited the highest levels of performance closely followed by group 2 (25% feedback). Group 3's (0% feedback) performance was the lowest overall.

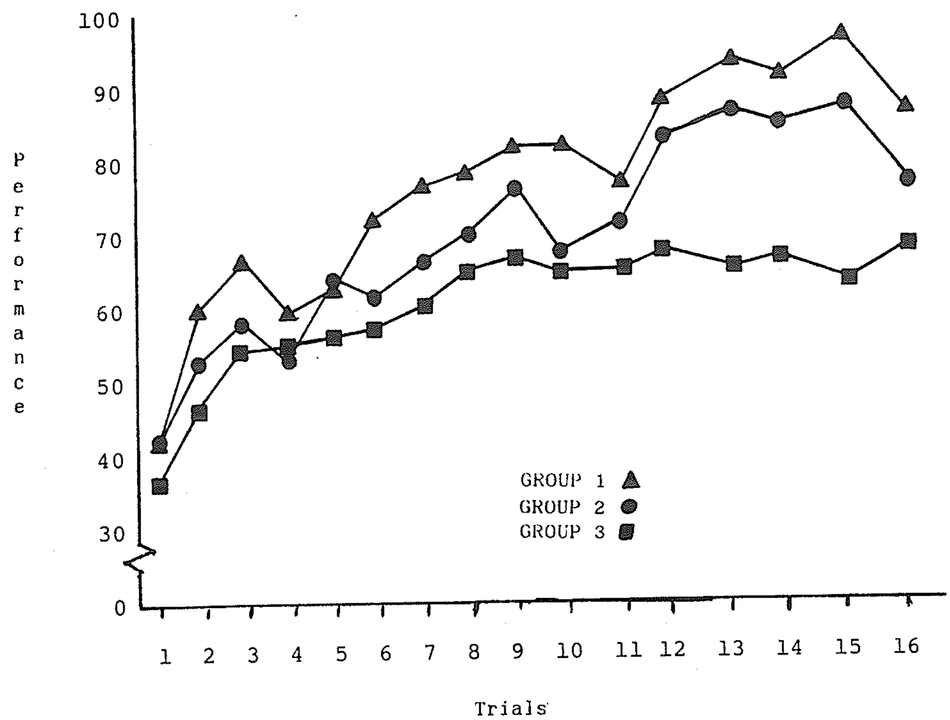
The Friedman Two-Way Analysis of Variance test was conducted on the performance data. Table 8 illustrates the results obtained for each trial. Results indicated no significant differences between the groups' performance scores. Figure 6 represents the sum of ranks per trial associated with the performance data for each group. The pattern of the graph indicated that the ranks of groups one (100%) and two (25%) were rather similar and consistently greater than group three's (0%) overall ranks.

<u>Achievement</u>

Subjects' achievement was reported by a percentage. Table 9 provides the descriptive statistics for the achievement results. Figure 7 represents the means for each groups' scores per trial. Overall achievement results (averages) appear high. All groups appear to be close to each other in terms of raw scores. However, for the most part of the experimental trials (trials 4 to 13), group one's (100%) achievement was the greatest followed by group two (25%) and then by group three (0%).

Figure 5

Average Performance



(Average performance as measured by the number of questions attempted during each 10 minute trial.)

Table 8

Friedman Two-Way Analysis of Variance of Performance Data

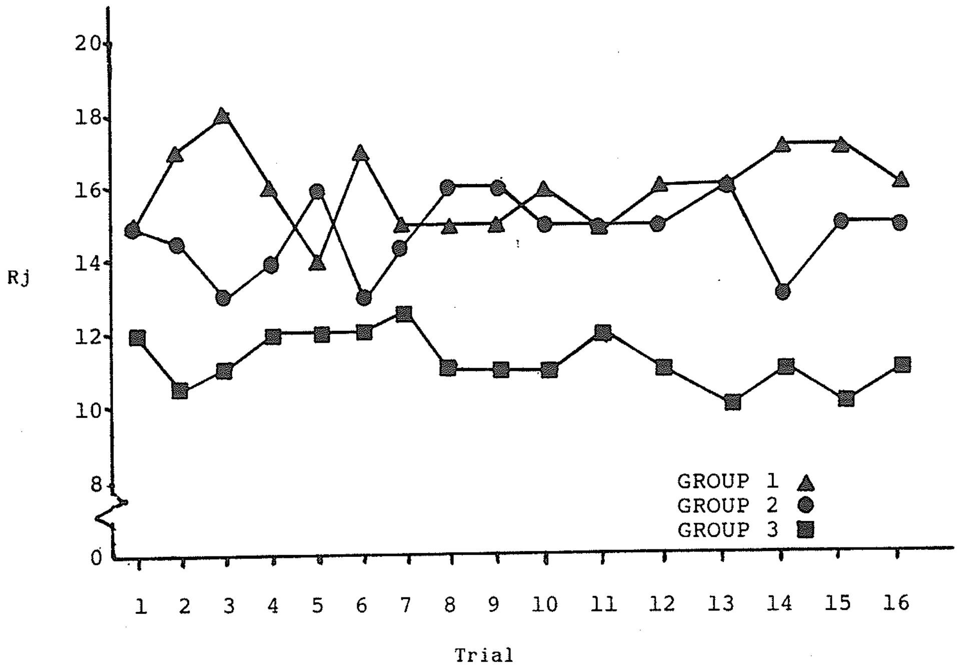
Trial	Group 1	Group 2	Group 3	χ_r^2
1	15	15	12	0.857117
2	17	14.5	10.5	3.071402
3	18	13	11	3.714259
4	16	14	12	1.142831
5	14	16	12	1.142831
6	17	13	12	1.99974
7	15	14.5	12.5	0.499974
8	15	16	11	1.999974
9	15	16	11	1.999974
10	16	15	11	1.999974
11	15	15	12	0.857117
12	16	15	11	1.999974
13	16	16	10	3.428545
14	17	13	11	1.28574
15	17	15	10	3.714259
16	16	15	11	1.999974

Note. Body of table consists of the sum of ranks.

* $p < 0.05$

Figure 6

Comparison of the Friedman Sum of Ranks for Performance Data



(Rj represents the sum of ranks.)

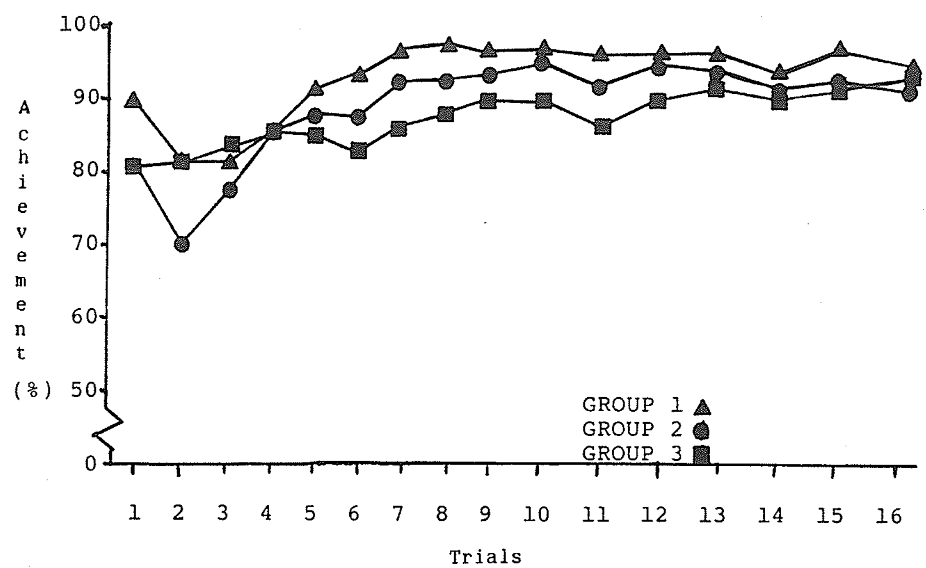
Table 9

Descriptive Statistics: Means and Standard Deviations for Achievement Data

Trial	Group 1		Group 2		Group 3	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
1	90.714	16.388	80.571	14.455	80.714	11.814
2	81.0	17.185	70.286	14.614	81.714	13.124
3	81.0	17.870	78.429	13.352	84.143	13.384
4	86.286	15.872	86.143	12.707	86.429	10.753
5	91.286	8.826	88.0	11.633	85.857	11.364
6	94.286	6.751	88.429	7.678	83.0	10.970
7	97.143	2.036	93.286	5.314	87.429	8.942
8	97.857	1.774	93.429	5.160	88.143	10.976
9	96.714	2.691	94.286	5.438	90.571	9.693
10	97.571	1.990	95.0	4.163	90.286	8.440
11	96.0	3.697	92.714	3.592	86.571	9.813
12	96.143	4.141	95.571	1.813	90.143	12.522
13	96.143	2.036	94.571	3.047	93.286	10.981
14	94.857	4.413	91.429	4.158	90.286	9.233
15	97.143	2.341	93.714	3.352	92.429	9.607
16	95.714	4.152	91.571	5.255	94.571	7.70

Figure 7

Average Achievement



(Average achievement represented as a percentage of questions correctly attempted for each 10 minute trial.)

Table 10

Friedman Two-Way Analysis of Variance of Achievement Data

Trial	Group 1	Group 2	Group 3	χ_r^2
1	19	9.5	12.5	2.785688
2	17	10	15	3.714259
3	14.5	12.5	15	0.499974
4	14	12.5	15.5	0.642831
5	17.5	11	13.5	3.071402
6	19.5	11.5	11	6.499972*
7	18.5	13.5	10	5.214258
8	18.5	12.5	11	4.499973
9	16	15.5	10.5	2.642831
10	17.5	14	10.5	3.499973
11	19.5	13	9.5	7.357115*
12	15.5	12.5	14	0.642831
13	14	12	16	1.14283
14	16.5	11.5	14	1.785688
15	17	11	14	2.571402
16	13.5	10.5	18	4.071402

Note. Body of table consists of the sum of ranks.

* $p < 0.05$

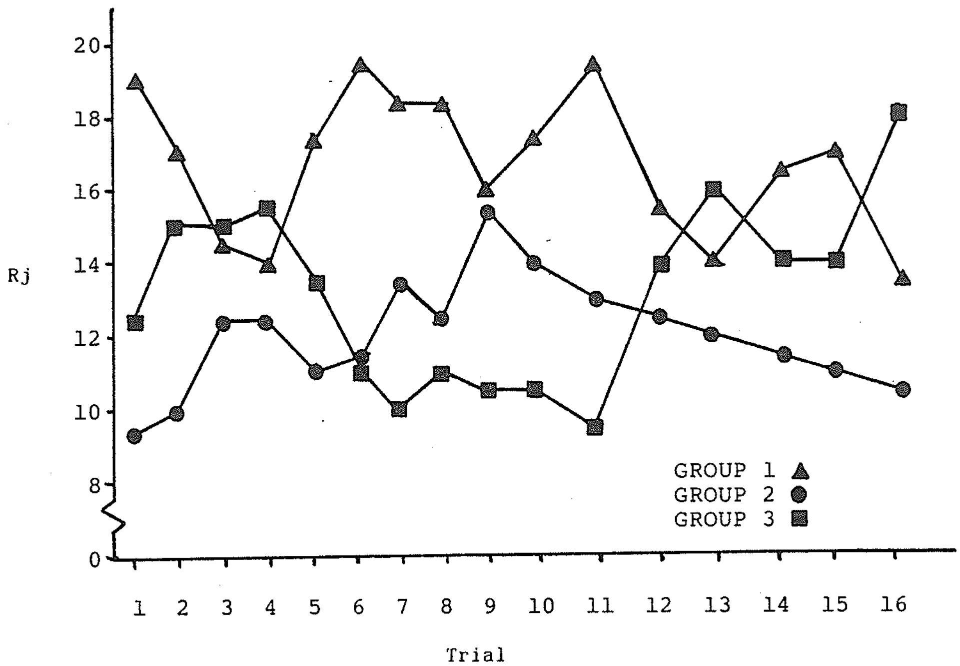
The Friedman analysis was conducted on the achievement data. Results are reported in Table 10. Rankings of the subjects' scores did reveal significant results for data reported in trials six and eleven. The data presented in Figure 8 reveals that the sum of ranks for group 1 (100%) were much greater than the other two groups sum of ranks for those significant trials. The remainder of the information portrayed in the graph is rather variable in nature.

Grouped Data

Grouped data refers to the compiling of the raw data for each subject in each group. Data was split into three categories of baseline trials (trials 1 to 3), experimental trials (trials 4 to 13) and extinction trials (trials 14 to 16). This was done for both performance and achievement data. The results were ranked and the Friedman test was conducted on the data. Table 11's data indicates that there were no significant differences for the grouped data pertaining to performance results or achievement results. Figure 9 illustrates that the performance sum of ranks for groups one (100%) and two (25%) were similar and both greater than group three's (0%) ranks. Figure 10 reports the achievement ranks of the three groups. A somewhat different result was evident than that indicated by the mean data reported in Figure 7. Figure 10 illustrates that group one's (100%) ranks were the greatest. Group three's (0%) ranks were greater for all three

Figure 8

Comparison of the Friedman Sum of Ranks for Achievement Data



(Rj represents the sum of ranks.)

Table 11

Friedman Two-Way Analysis of Variance of Grouped Data

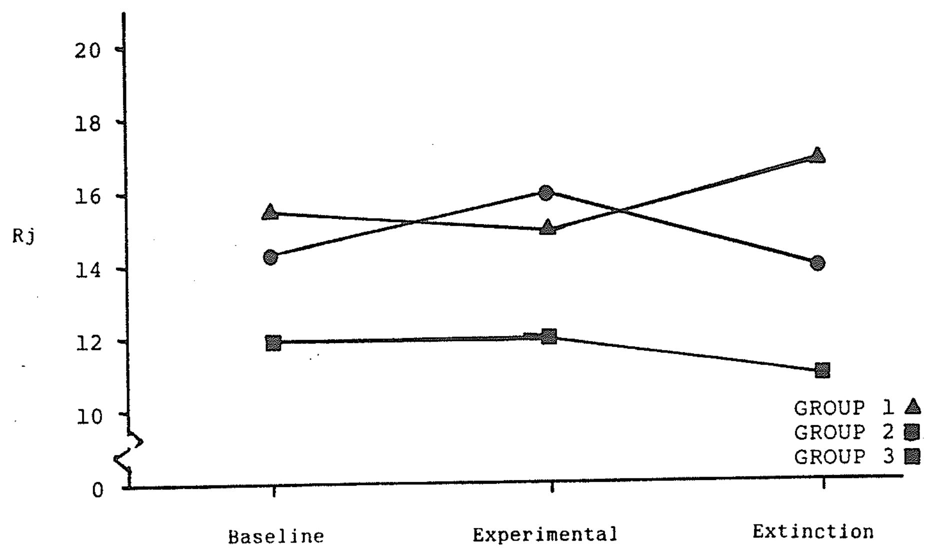
Trials	Group 1	Group 2	Group 3	χ_r^2
	Performance Data			
Baseline	15.5	14.5	12	0.928545
Experimental	15	16	12	5.285687
Extinction	17	14	11	2.571402
	Achievement Data			
Baseline	16	12	14	1.14283
Experimental	18	11	13	3.714259
Extinction	16.5	10	15.5	3.499973

Note. Body of table consists of the sum or ranks.

*$p < 0.05$

Figure 9

Comparison of the Friedman Sum of Ranks for Grouped Performance Data



(Rj represents the sum of ranks.)

trial groupings than the ranks of group two (25%). The ranks of group two (25%) indicated a continual decline throughout the experiment.

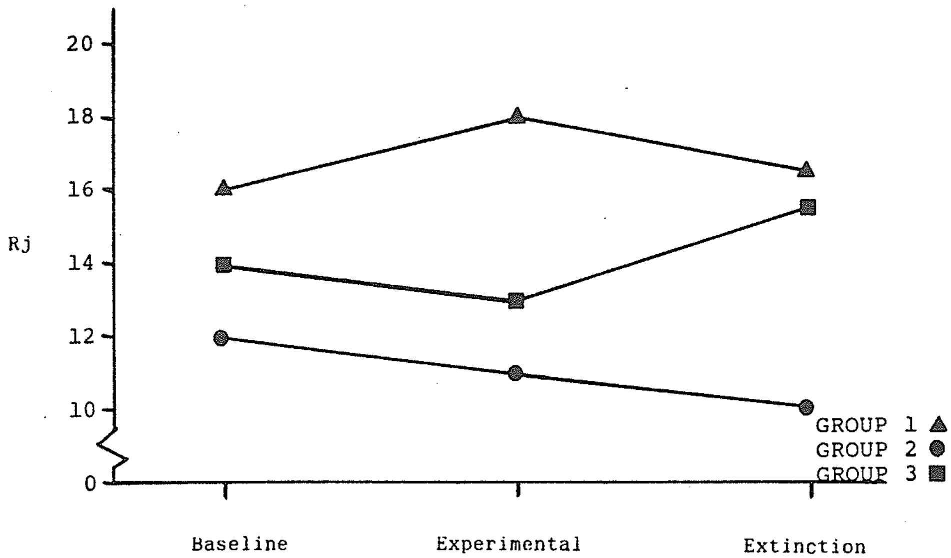
Certainty Scale

Subjects were asked to predict how well they would do on their next computer trial. They were also asked to state how certain they were about their prediction. They indicated their level of certainty on a linear scale ranging from a low of zero to a high degree of certainty of 10. Subjects were asked to complete this task four times throughout the experiment. The Wilcoxon Matched-Pairs Signed-Ranks Test was used to analysis the data. Each group was separately compared to each other group to assess if there were differences between the sets of results. Table 12 presents the results of the analysis. Significant differences were found between groups one (100%) and two (25%) on reporting sessions two and four. Differences between groups one (100%) and three (0%) were significant for the second reporting session only. There were no significant differences between groups two (25%) and three (10%).

The averages of the reported certainty levels for all three groups is presented in Figure 11. Certainty levels appear to be similar for all three groups of subjects for reporting session one. By reporting sessions three and four, the levels of groups one (100%) and three (0%) move toward each other while group two's

Figure 10

Comparison of the Friedman Sum of Ranks for Grouped Achievement Data



(Rj represents the sum of ranks.)

Table 12

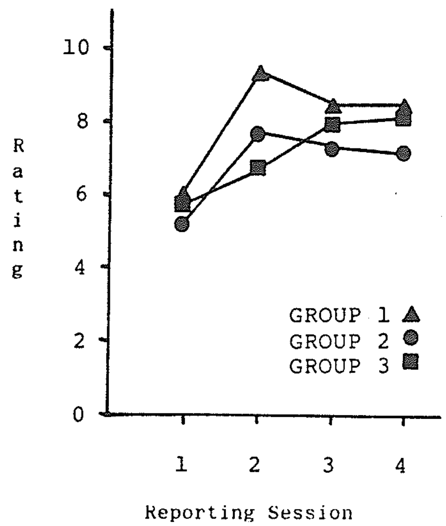
Wilcoxon Matched-Pairs Signed-Ranks Test Comparing Group Results on the Certainty Scale

Reporting Session	Pairs	Sum of Ranks		z
		Positive	Negative	
	Groups One and Two			
1	6	16.0	5.0	-1.15311
2	7	24.0	4.0	-1.69031*
3	6	18.0	3.0	-1.57243
4	6	19.0	2.0	-1.78208*
	Groups One and Three			
1	5	9.0	6.0	-0.40452
2	7	26.0	2.0	-2.02837*
3	3	6.0	0.0	-1.60357
4	5	10.0	5.0	-0.67420
	Groups Two and Three			
1	6	7.0	14.0	-0.73380
2	6	15.0	6.0	-0.94346
3	6	6.5	14.5	-0.83863
4	6	4.0	17.0	-1.36277

* $p < 0.05$ (one-tailed test)

Figure 11

<u>Certainty Ratings for Predicted Achievement</u>



(Maximum rating on certainty scale = 10.)

(25%) level drops below that of the other groups.

Causal Dimension Scale

The Causal Dimension Scale consists of the three separate components of Stability, Locus and Control. Each of the components consists of a scale of twenty-seven (27) possible points. A high score on any of the scales indicates the subject possesses a high degree of that particular dimension. Subjects completed this scale on the same four reporting sesssions they completed the certainty scale.

Stability scale. The results of this scale were analysized by the Wilcoxon test. Table 13 portrays the data. Groups one (100%) and two (25%) produced significant differences on reporting sessions two and four. Groups one (100%) and three (0%) produced no significant results. Differences of groups two (25%) and three (0%) were significant on reporting sessions two and three.

Locus scale. Table 14 reveals that the Wilcoxon test conducted on the Locus Scale data was significant for groups one (100%) and two (25%) on trial four and for groups two (25%) and three (0%) on trials two and three. Differences between groups one (100%) and three (0%) were not significant.

Control scale. Groups one (100%) and three (0%) had a significant difference for the control scale on reporting session three as shown by Table 15. Groups two (25%) and three (0%) had significant differences on reporting sessions three and four. No

Table 13

Wilcoxon Matched-Pairs Signed-Ranks Test Comparing Group Results on the Stability Scale

Reporting Session	Pairs	Sum of Ranks		z
		Positive	Negative	
		Groups One and Two		
1	7	14.5	13.5	0.08452
2	5	15.0	0.0	-2.02260*
3	7	23.0	5.0	-1.52128
4	6	19.0	2.0	-1.78208*
		Groups One and Three		
1	7	12.5	15.5	-0.25355
2	7	11.5	16.5	-0.42258
3	7	19.0	9.0	-0.84515
4	7	13.0	15.0	-0.16903
		Groups Two and Three		
1	7	12.0	16.0	-0.33806
2	7	2.5	25.5	-1.94385*
3	7	4.0	24.0	-1.69031*
4	6	3.5	17.5	-1.46760

* $p < 0.05$ (one-tailed test)

Table 14

Wilcoxon Matched-Pairs Signed-Ranks Test Comparing Group Results on the Locus Scale

Reporting Session	Pairs	Sum of Ranks		z
		Positive	Negative	
	Groups One and Two			
1	5	10.5	4.5	-0.80804
2	7	24.0	4.0	-1.69031
3	5	13.5	1.5	-1.61808
4	7	26.0	2.0	-2.02837*
	Groups One and Three			
1	6	9.0	12.0	-0.31449
2	5	6.0	9.0	-0.40452
3	5	4.0	11.0	-0.94388
4	6	12.5	8.5	-0.41931
	Groups Two and Three			
1	7	12.0	16.0	-0.33806
2	7	1.5	26.5	-2.11289*
3	6	1.0	20.0	-1.99174*
4	7	9.0	19.0	-0.84515

* $p < 0.05$ (two-tailed test)

Table 15

Wilcoxon Matched-Pairs Signed-Ranks Test Comparing Group Results on the Control Scale

Reporting Session	Pairs	Sum of Ranks		Z
		Positive	Negative	
	Groups One and Two			
1	6	14.0	7.0	-0.73380
2	7	20.0	8.0	-1.01418
3	7	10.5	17.5	-0.59161
4	7	20.5	7.5	-0.27190
	Groups One and Three			
1	7	13.5	14.5	-0.08452
2	6	13.5	7.5	-0.62897
3	7	0.0	28.0	-2.36643*
4	7	5.0	23.0	-1.52128
	Groups Two and Three			
1	6	3.5	17.5	-1.46760
2	6	8.0	13.0	-0.52414
3	7	2.0	26.0	-2.02837*
4	7	1.5	26.5	-2.11289*

* $p < 0.05$ (two-tailed test)

significant differences were uncovered for the comparison of groups one (100%) and two (25%).

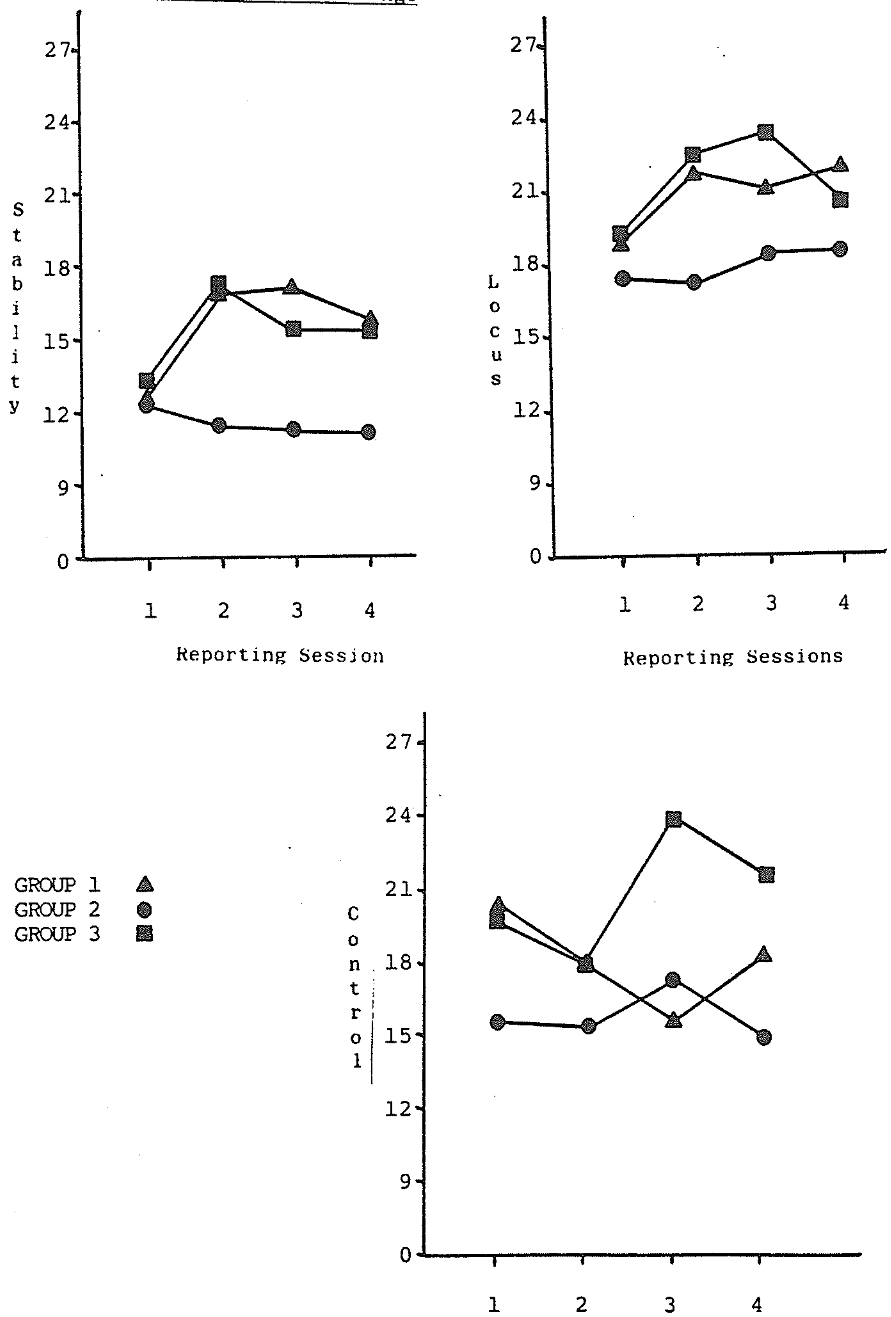
Figure 12 graphically represents the averages of all groups on all three scales for each reporting session. Stability scores for groups one (100%) and three (0%) were rather similar. Lower score levels were reported by the subjects of group two (25%). The same pattern was evident for the locus scale. The control scale results revealed a different configuration. Group two's (25%) score level remained relatively low but constant as compared to the other groups. Group one (100%) and three (0%) score levels on reporting session one were very similar and higher than group two's (25%) score level. Both group one's (100%) and three's (0%) score level dropped to the same point for reporting session two. Reporting session three indicated a further drop in score for group one (100%) (lower than group two's level) and a dramatic rise in the level of group three's (0%) score. Group one's (100%) level rose, group two's (25%) level dropped to its lowest point and group three's (0%) level dropped slightly for reporting session four.

Pre-test and Post-test

Figure 13 displays the average scores for each group on the pre-test and the post-test results. The average score for group two (25%) on the pre-test was the highest of the subject groupings which was followed by the results of group three (0%) and then by

Figure 12

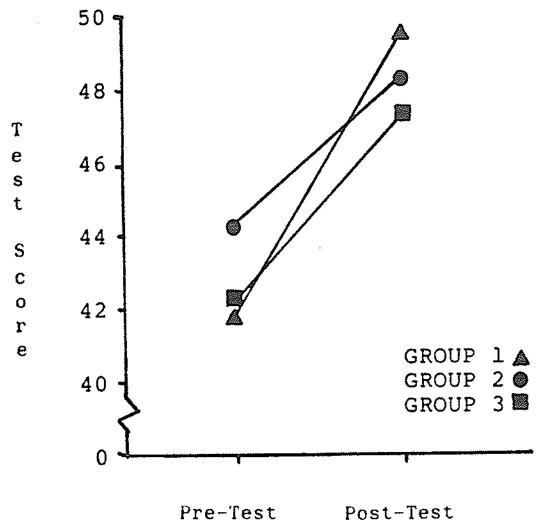
Causal Dimension Scale Ratings



(Causal dimension ratings on the stability, locus and control scales. Reporting sessions 2, 3 and 4 were influenced by the feedback conditions. Maximum score on each scale is 27.)

Figure 13

Group Average Pre-Test, Post-Test Results



(Total possible test score = 50 points.)

group one (100%). Group one (100%) experienced the greatest overall effect of the treatment and scored the highest group average on the post-test. Group two's (25%) result was second highest followed by group three (0%).

To test for significant differences between the groups' scores on both tests, the Wilcoxon test was utilized. As shown in Table 16, there were no significant differences between any of the group comparisons for either test.

Intellectual Achievement Responsibility (IAR) Questionnaire

The results of the IAR (which was administered prior to the experiment) were compared to the results of all other dependent variables in an attempt to establish possible relationships. Since the results of the Causal Dimension Scale and the Certainty Scale were affected by the experimental manipulation, results for the first reporting session (prior to experimental influence) were used in the comparison. Results of the Spearman Rank Correlation are found in Table 17. No comparisons were found to be significant.

Post hoc

Rationale. During the statistical analysis of the data, it was thought by the experimenter that significant information was being lost in the Friedman analysis of performance and achievement data. Therefore the Wilcoxon test was conducted on those sets of results. Even though the Friedman analysis did not reveal

Table 16

Wilcoxon Matched-Pairs Signed-Ranks Test Comparing Group Results for Pre-Test and Post-Test Data

Groups Compared	Pairs	Sum of Ranks		z
		Positive	Negative	
		Pre-Test Data		
1 and 2	4	0.0	10.0	-1.82574
1 and 3	5	5.5	9.5	-0.53936
2 and 3	5	13.0	2.0	0.13801
		Post-Test Data		
1 and 2	6	19.0	2.0	-1.78208
1 and 3	5	13.5	1.5	-1.61808
2 and 3	3	3.0	3.0	0.0

* $p < 0.05$ (two-tailed test)

Table 17

Spearman Bank Correlations of Dependent Variables with Results of the IAR Scale

Dependent Variables	Correlation (t)
Academic Evaluations	
Pre-Test	0.5790356
Post-Test	-1.1808769
Performance Data	
Total (Trials 1-16)	-0.4707295
Baseline (Trials 1-3)	-0.2903878
Experimental (Trials 4-13)	0.7291264
Extinction (Trials 14-16)	0.2932616
Achievement Data	
Total (Trials 1-16)	-1.4886556
Baseline (Trials 1-3)	1.3672403
Experimental (Trials 4-13)	0.9904275
Extinctions (Trials 14-16)	0.381615
Causal Dimension Scale (Session 1)	
Locus	1.4837627
Control	-1.2900388
Stability	-0.7532268
Certainty Scale	
Session 1	-1.6905457

* $p < 0.05$ (two-tailed test)

significant results for the performance data, such data was included in the post hoc analysis.

Performance data. Table 18 indicates the results of the Wilcoxon test on the performance data. Significant differences were found between groups two (25%) and three (0%) on trials 12 and 15 with group two (25%) out-performing group three (0%) on both trials. A significant difference was also found between groups one (100%) and three (0%) also on trial 15 where group one (100%) out-performed group three (0%).

Achievement data. The Friedman test did reveal significant differences for achievement data. The Wilcoxon test also indicated significant differences (Table 19). For groups one (100%) and two (25%), significant differences were reported for trials one, two, six, seven, eight, fourteen and fifteen. In each case group one's (100%) achievement was greater than group two's (25%) achievement. The comparison of group one (100%) and three (0%) revealed significant differences on trials six, seven, eight, ten and eleven where the achievement of group one (100%) was greater than that of group three (0%). Trial ten revealed a significant difference pertaining to achievement results between groups two (25%) and three (0%). Group's two (25%) achievement was greater than group's three (0%) achievement.

Standard deviations. Another interesting comparison was discovered after the data had been collected. That comparison

Table 18

Wilcoxon Matched-Pairs Signed Ranks Test Comparing Performance Data

Trial	Groups		
	1 and 2	1 and 3	2 and 3
1	-0.42258	-1.01418	-1.09870
2	-0.76064	-1.35225	-1.15311
3	-0.76064	-1.35225	-0.67612
4	-0.50709	-0.67612	-0.16903
5	-0.33806	-0.25355	-0.76064
6	-0.67612	-1.01418	-0.76064
7	-0.76064	-0.92967	-0.73380
8	-0.50709	-1.35225	-0.50709
9	-0.16903	-1.18322	-1.26773
10	-1.01418	-1.18322	-0.16903
11	-0.33806	-0.67612	-0.50709
12	-0.16903	-1.18322	-1.8593*
13	-0.33806	-1.35225	-1.52128
14	-0.16903	-1.35225	-1.35225
15	-0.76064	-1.69031*	-1.85934*
16	-0.50709	-1.35225	-0.39802

Note. Body of table consists of z scores.

* $p < 0.05$ (one-tailed test)

Table 19

Wilcoxon Matched-Pairs Signed Ranks Test Comparing Achievement Data

Trial	Groups		
	1 and 2	1 and 3	2 and 3
1	-2.36643*	-1.09870	-0.31449
2	-1.69031*	-0.16903	-1.60579
3	-0.94346	-0.67612	-1.60579
4	-0.16903	-0.16903	-0.10483
5	-1.43676	-1.15311	-0.08452
6	-2.20140*	-2.02837*	-0.92967
7	-1.78208*	-2.02260*	-1.35225
8	-2.20140*	-1.85934*	-1.09870
9	-0.84515	-1.52218	-1.15311
10	-1.52128	-1.88691	-1.85934
11	-1.43676	-2.20140*	-1.18322
12	-0.41931	-0.94388	-0.67612
13	-1.01418	0.0	-0.67612
14	-1.69031*	-0.94346	-0.31449
15	-1.94385*	-0.94388	-0.08452
16	-1.57243	-0.33806	-1.18322

Note. Body of table consists of z scores.

* $p < 0.05$ (one-tailed test)

entailed a closer look at the groups' standard deviations for performance scores and achievement scores.

The variability of the performance data per trial, as shown in Figure 14, is rather erratic. However, each group appears to begin the trails with standard deviations similar in nature. As the experiment progresses the variation of scores between subjects in the groups increases. Generally speaking, the increases in score variation for groups one (100%) and three (0%) appear to be similar in nature whereas group two's (25%) variation appears to be less than the other two groups.

The standard deviations of the groups' scores per trials for achievement data revealed a different pattern as illustrated by Figure 15. Standard deviations appeared to be high at the beginning of the computer trials and became smaller as the experiment progressed. The variation in the scores of group three (0%) appeared to remain constant as compared to the other two groups. Indeed, the standard deviations of group three (0%) were higher than those of the other groups for the majority of the experiment.

Conclusion

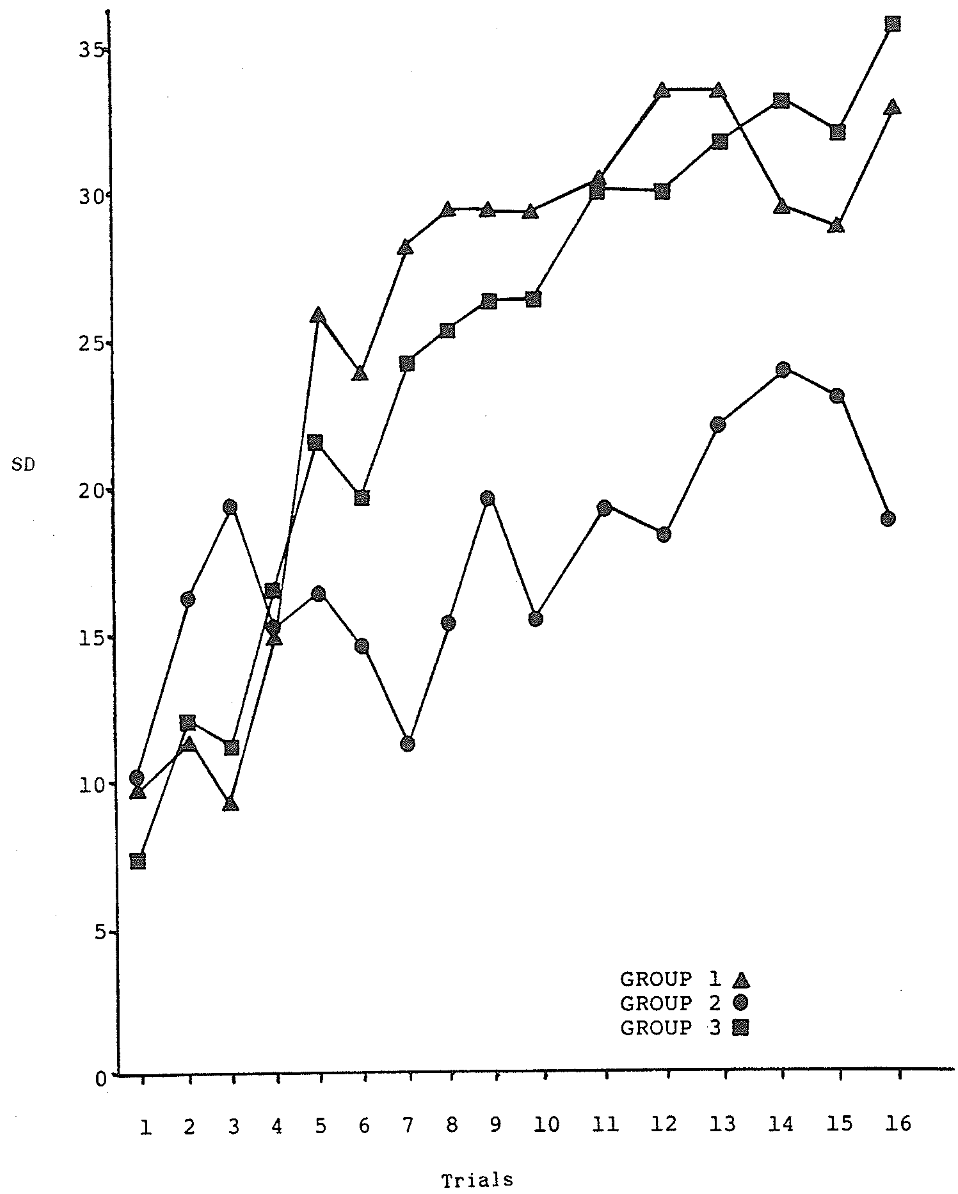
The results of the experiment have been presented. Chapter five will discuss the results in light of how they pertain to:

1) The hypotheses of this study.

2) The application of Weiner's theory in a middle years

Figure 14

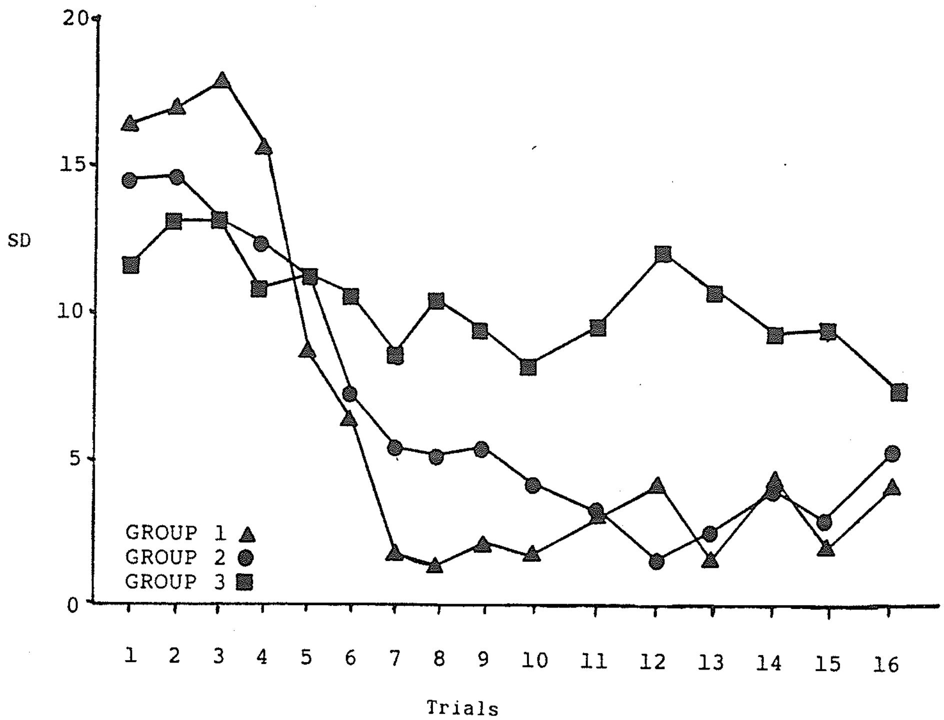
Comparison of Standard Deviations for Performance Results



(Comparison of standard deviations (SD) for performance results.)

Figure 15

Comparison of Standard Deviations for Achievement Results



(Comparison of standard deviations (SD) for achievement results.)

school setting.

3) The indication of the existence of software design principles for products aimed at the middle years school setting.

4) Unanswered questions.

5) Implications for future research.

CHAPTER FIVE

Discussion

General Overview of Results

Increased achievement. The results of this study indicate that CAL administered feedback schedules do affect student performance rates and achievement levels for a mathematic computation task. Although the majority of the results were not statistically significant, a review of the collected data do indicate performance patterns that must be considered in the design and implementation of courseware for middle years students.

Support for a theory. Particular results of this study provide supportive evidence for Weiner's (1979) theory of Causal Attribution as applied to a natural academic environment. In addition, this study corroborates the findings reported by Fontaine (1974), Valle and Frieze (1976), Weiner, Niesenberg and Goldstien (1976), and Rest (1976) dealing with the topic of Weiner's theory of motivation.

Contradictory results. Other results of this study contradict previous research efforts. These results require further interpretation and explanation which may lead to an important characteristic of causal attribution as it pertains to the realm of computers.

Conclusions and Interpretations

Supportive results. The evidence obtained through the present study supports the following ideas:

Feedback enhances performance. Feedback procedures enhance the performance rates of students' work. Although differences of performance rates of the three groups were not statistically significant using the Friedman Analysis (Table B), the graphical representation of the groups' mean results (Figure 5) indicate that subjects receiving feedback (groups one, 100% and two, 25%) delivered by CAL methods completed more problems than those subjects not receiving feedback (group three, 0%). The pattern formed by comparing the groups' sums of ranks calculated for the Friedman Analysis (Figure 6) concurs with this conclusion. The post hoc analysis using the Wilcoxon procedure (Table 18) did reveal some significant results for certain trials. These results appear to be isolated yet support the idea that feedback conditions are more condusive to increasing student performance rates than the condition of no feedback.

This conclusion corroborates the ideas of B. F. Skinner (1968) and Ferster and Skinner (1957) that immediate, constant feedback will increase performance rates. Weiner's (1979) studies also produced evidence supporting this idea. Although this study's original research hypothesis cannot be accepted, results obtained do have educational significance. That is to say, when an educator wants to increase the time-on-task behavior exhibited by students, the teacher could incorporate the condition of 100% feedback into a planned teaching strategy.

<u>Feedback increases achievement</u>. Feedback conditions increase the achievement levels of students. The mean achievement scores of subjects (Figure 7) reveal a pattern supporting such an idea. Separate group scores are very close, perhaps due to the ease of mastering the computation task, yet the scores of the feedback groups (one, 100% and two, 25%) are above those of the scores of the no feedback group (three, 0%). The Friedman Analysis (Table 10) did produce significant results but only on two trials. The sum of ranks data graphically represented in Figure 8 imply the idea that the condition of constant feedback (group one, 100%) produces higher student achievement levels. Group two's (25%) sum of ranks indicates a gradual decline of achievement from trial 9 to the end of the experiment. This result, contrary to the mean score data, may indicate that the achievement ability of subjects in group two (25%) are more evenly matched than that of the other two groups. Is this because of the independent variable or is it an artifact of the random matching process? When data are grouped (Figure 9) the pattern originally predicted is shown for the experiment trials. The fact that group two (25%) does not have a high scoring individual may account for these patterns. Perhaps it is an artifact of the matching process.

Nevertheless, the data of the study, including post hoc analysis using the Wilcoxon method (producing a few more significant results), support the tenants of previous researchers (Ferster and Skinner, 1957; Skinner, 1968) that continual immediate feedback will produce increased achievement gains in students. Similar to the performance data, the original research hypothesis of this study cannot be accepted. Statistical significance is intermittent and scarce. However, educational significance is present in the patterns produced by the data. When a teacher is interested in increasing the achievement levels of students, the results of this study indicate that feedback procedures should be used. Greatest gains have been shown to occur under the 100% feedback condition.

Feedback affects causal attribution. Causal attributions made by the subjects of this study support the findings of Weiner (1979) and Russell (1982). The most significant results of the present study were uncovered testing the hypotheses related to causal attribution.

Attributions reported during session one were not affected by the influences of the independent variables. These results of the individual groups were predicted to be similar. Such was the case. The Wilcoxon procedure (Table 13) produced significant results supporting the original research hypotheses for a variety of the remaining reporting sessions. Those results that were not significant were very close to being so (refer to Table 20).

The hypotheses that subjects in group one (100%) and group three (0%) would attribute the perceived cause of their progress to stable causes while group two (25%) subjects' attributions would be made to unstable causes is accepted. Figure 12 represents the relationship that is statistically, educationally and theoretically significant. The stability of a causal attribution will ultimately affect a student's self-concept. A failing student who has made a stable causal attribution will expect future failure to occur. This reduces performance and motivation levels within the student. It is crucial for educators to use appropriate feedback procedures that fit individual student needs. The results of this study imply this to be the case. The idea that one CAL program is beneficial to all who use it is challenged by the empirical evidence of this study.

Locus of control not a factor. The psychological construct of Locus of Control was not related to any of the dependent variables of this study. Weiner (1976, 1979) developed evidence which suggested that Locus of Control was not associated to causal attribution as was once believed. The subsequent theory separated locus and control to develop two separate dimensions not related to the original idea of Locus of Control. Spearman Rank correlation procedures comparing the results of the IAR questionnaire (Crandall, Katkovsky and Crandall, 1965) with the

Table 20

Significance Levels of the Wilcoxon Test on Stability Results

Groups Compared	Reporting Session	Statistical Significance
1 (100%) and 2 (25%)	1	ns
	2	0.03*
	3	0.07
	4	0.04*
1 (100%) and 3 (0%)	1	ns
	2	ns
	3	ns
	4	ns
2 (25%) and 3 (0%)	1	ns
	2	0.03*
	3	0.05*
	4	0.07

Note. Information on this table is based on that of Table 13. Statistical signifcance reported by achievement alpha levels.

* $p < 0.05$

pertinent data produced by the various dependent variables reveal no significant relationships (Table 17). In fact, the data of the locus and control segments of the causal dimension scale were not related to the Locus of Control results. The causal dimension scale (Russell, 1982) was developed specifically to be utilized with Weiner's (1979) theory. The results of this study, which accept the three research hypotheses related to causal stability plus the Locus of Control hypothesis, offer more empirical credence to the theoretical ideas of Weiner's Attributional Theory of Motivation.

Matched treatment groups similar. Pre-test and post-test results (Figure 13) indicate that the many test scores of the subjects in all three groups increased dramatically after CAL practices were experienced regardless of whether or not feedback procedures were involved. The Wilcoxon procedure (Table 16) indicates that the groups' separate test achievement levels were not significantly different for either the pre or post test sessions. The indication is that the achievement levels of the separate groups are comparable with each other. This was expected. When the pre-test scores were compared to the post-test scores for individual subjects using the Wilcoxon test, the resulting value of 3.6 was produced which is extremely statistically significant. The indication here is that all three treatment groups were evenly matched on the decimal computation skill factor prior to the onset of the experiment. The exposure to CAL repetition dramatically affected every subjects' future mathematic test achievement regardless of which feedback condition the subject had experienced. This is an educationally significant result. It implies that teachers can elevate the attained achievement levels of students in mathematical computation by providing them with numerous practice sessions. An advantage with CAL is that the computer never tires of the assigned task. Such sessions need not be of a prolonged duration. The procedure of this study illustrates how a ten minute session for a period of ten days can produce achievement gains. CAL practices utilizing a drill and practice format have been shown to be an effective instructional aid for educators.

CAL increases automaticity. Drill and practice procedures of CAL lead to an increased degree of automatization of basic mathematic computation skills. Case (1980) professes that large doses of practice in mathematic computations will produce skills that become second nature to the subjects. Results of previous studies (Gagne, 1982; Lesgold, 1982; Torgesen, 1986) concur with Case's ideas. Although this study did not state a research hypothesis regarding CAL and automatization, the results do strongly support this educationally significant characteristic of learning. Drill and practice format of courseware may be simplistic but the benefits derived from such procedures in mathematics training cannot be disputed.

Nonsupportive results. The evidence obtained through the present study does not support the following ideas:

Certainty and stable causal attribution. Subjects attributing their progress to stable causes will have a greater degree of certainty pertaining to their predicted future academic outcomes than subjects attributing their progress to unstable causes. It was predicted by this study that subjects in group one (100%) and three (0%) would have certainty ratings higher than subjects in group two (25%). Certainty ratings for reporting session one were predicted to be similar since the influence of the independent variables had not been felt. Such was the case for session one. In fact, the pattern displayed by Figure 11 implies support for the hypothesis. Review of the data revealed by the Wilcoxon procedure (Table 12) indicates contrary evidence. There were significant differences between groups one (100%) and two (25%) on two of the three critical sessions. This was predicted. Groups one (100%) and three (0%) were predicted to be similar. This prediction was not upheld. Significant results were found for one of the sessions with group one's (100%) level being consistently higher than that of group three (0%). The levels of group three (0%) were predicted to be greater than those of group two (25%) subjects. This was not always the case for the reporting sessions and no significant differences were reported.

The evidence is too weak to even suggest a possible pattern implying educational significance. Definitely group one's (100%) certainty level was the greatest of the three groups. It is possible that if the experiment had continued that the predicted pattern would emerge. The lack of supportive results may also be due to the specific certainty scale that was developed for this study. The ten point likert-type scale may not be adequate for assessing the subjects' certainty levels regarding predicted academic outcomes.

Weiner's (1979) model states that certainty is related to the stability of causal attributions. Hence, the research hypothesis tested in this study. Evidence obtained by this study is such that the hypothesis cannot be accepted and the theoretical notion cannot be supported. Again, this may be due to a flaw in the instrument developed and implemented in this study.

Resistance to extinction. Subjects attributing their progress to unstable causes will have performance levels more resistant to extinction than subjects reporting stable causal attributions.

Extinction involves the withdrawal of feedback procedures from subjects as they continued to perform the CAL task. Group one subjects' (100% feedback) performance levels were predicted to drop quickly and dramatically during the extinction period. Since group two (25% feedback) received intermittent feedback, their performance levels were predicted to stay relatively high and unchanged; resistant to extinction. Group three received no feedback and it was predicted that their performance level would remain low and unchanged since the extinction trials were identical to the experimental trials the subjects had previously experienced.

Previous research. The predictions of this study are well rooted in previous works. Previous studies supporting the idea that the behaviors of subjects who have received intermittent reinforcement are resistant to extinction have been conducted by Ferster and Skinner (1957), Jenkins and Stanley (1950), and Rest (1976). Weiner's (1979) work supports the prediction but emphasizes that the stability of the causal attribution is affected by the reinforcement schedule and thereby affects the degree of resistance to extinction. The results of the present study do not support the findings of the previous studies cited and make acceptance of the research hypothesis impossible.

Present study. Performance data for the three extinction trials (trials 14, 15 and 16) are not significant statistically. A review of Figure 5 provides the reader with a graphical representation of the situation. Perhaps the uncovered pattern is the result of an extinction period that was too short. The actual phenomenon was not given the adequate time to unfold. Such may be the case and therefore indicates a design flaw of the study.

Could there possibly be another explanation?

<u>CAL confounds the attribution process</u>. It is important to once again point out that this study's results pertaining to the extinction rates of behavior are not statistically significant and that the argument to follow is of a purely speculative nature. Nevertheless, it is believed to be an important discovery of the present study. All other previous studies investigating resistance to extinction cited by this study produced empirical evidence to support their claims. Conclusions pertaining to some of the results of this study have been supportive of previous theories. Yet on this issue, contrary results are produced. The fact remains that all previous studies did not incorporate computers into their investigation. Could the presence of computers somehow confound an individual's causal attribution process?

<u>Causal attribution and the reinforcing agent</u>. Subjects were asked to rate the stability of the perceived cause for their academic progress on the CAL task. They were not specifically asked to rate the stability of the feedback being administered by the reinforcing agent (computer). Perhaps subjects in group two (25%) held two sets of perceptions each differing in the degree of stability. Subjects may have had a perception of their progress (unstable causes due to random feedback) and a perception of the computer administered feedback (stable causes due to the

uncontrollability of the machine). That is to say, subjects in group two (25%) may have had the attitude which is pervasive in society today that a machine (computer) is somewhat beyond the influence of an individual. The computer may have been regarded as an entity which provided feedback when "it felt like it". In this sense, the feedback can be seen as being a component of the task; external and uncontrollable and indeed a stable condition since the task is perceived by the subject as being preordained and administered by a machine. The subjects of group one (100%) may have developed the same perception hence experienced a similar drop in performance rates as group two (25%) subjects did during the extinction trials. Subjects in group three (0%) received no feedback from the computer and therefore would not develop such a perception. An explanation of why this study's results are contrary to previous works conducted on feedback schedules and extinction rates has been presented.

If this speculation is indeed true, it may have profound implications for CAL designs in education and for our perceptions of our highly technological society. One must keep in mind though that the results of this study may be a result of a methodological design flaw previously stated. Nevertheless, this issue requires further attention.

Table 21

Judgments of Significance for Research Hypotheses

Research Hypothesis	Statistical Test	Statistical Significance	Educational Significance	Educational Implications
1. Performance rates (number of questions attempted) will be greatest for group 2 (25%) followed by group 1 (100%) and lowest for group 3 (0%); (25% > 100% > 0%)	Friedman Wilcoxon (post hoc)	ns 0.05 on two of sixteen trials	- feedback enhances performance rates - 100% feedback produced the greatest performance rates - research hypothesis not accepted.	- feedback procedures should be used whenever performance rates of students are to be increased - feedback procedures increase the amount of student time-on-task behavior - the condition of 100% feedback will best achieve desired performance rate - CAL courseware incorporating 100% feedback condition will probably produce greatest performance rates.
2. Average achievements levels of all groups will be similar; (100% = 25% = 0%)	Friedman Wilcoxon (post hoc)	0.05 on two of sixteen trials 0.05 on nine of sixteen trials	- feedback enhances achievement levels - 100% feedback most effective condition to increase achievement levels - research hypothesis not accepted.	- feedback procedures should be used whenever achievement levels of students are to be increased - greatest achievement level gains will be produced by the condition of 100% feedback - CAL courseware designed with 100% immediate feedback will increase the possibility of student success.

Table 21 - continued

3. Performance rate of group 2 (25%) will be more resistant to extinction than the rate of group 1 (100%); group 3 (0%) rate will not be affected; (25% > 100%).	Friedman Wilcoxon (<u>post hoc</u>)	ns 0.05 on one of sixteen trials	- extinction rates of groups similar - results contrary to previous studies - implies underlying characteristic requiring further investigation - research hypothesis not accepted	- feedback withdrawal will produce behavior extinction regardless of schedule - maintenance of performance levels will require maintenance of feedback procedures - CAL practices should maintain some form of feedback schedule - CAL administered feedback procedures appear to alter predicted extinction patterns - future research is necessary.
4. Group 2 (25%) will attribute their performance to unstable causes.	Wilcoxon	0.05 (overall)	- results support Weiner's theory - imply CAL design principle - research hypothesis accepted	- unstable causal attributions lead to increased motivation level (performance); theoretically but not statistically supported by this study's evidence on performance - CAL feedback schedules of an intermittent nature will increase a student's motivation level and time-on-task behavior as compared to a condition of 0% feedback

Table 21 - continued

				- intermittent feedback produces uncertain expectancies of future success or failure; failing students are provided with an opportunity to loose their negative expectations.
5. Group 1 (100%) will attribute their performance to stable causes.	Wilcoxon	0.05 overall	- results support Weiner's theory - imply CAL design principle - reserach hypothesis accepted	- successful students attributing performance to stable causes will maintain a constant level of performance; occasional failure seen as bad luck - failing students attributing performance to stable causes will maintain a low level of performance due to always failing; occasional success seen as merely luck - CAL procedure of 100% feedback would be beneficial for already successful students and damaging for failing students - feedback scheduling should be chosen on the bases of an individual student's needs - commercial drill and practice packages should provide a feedback schedule option

Table 21 - continued

6. Group 3 (0%) will attribute their performance to stable causes	Wilcoxon	0.05 overall	- results support Weiner's theory - imply CAL design principle - research hypothesis accepted	- same implications as suggested for hypothesis 5 - 0% feedback results in lower performance and lower achievement - student knowledge of success or failure delayed - condition restricts the ability of the teacher to alter student self-concept - condition not recommended for effective educational or CAL procedures.
7. Certainty ratings for future performance will be higher for group 1 (100%) than group 2 (25%); (100% > 25%)	Wilcoxon	0.05 on three of four sessions (predicted)	- supports Weiner's theory - research hypothesis accepted	- certainty and stability closely related, therefore student self-concept of importance - results reinforce implications previously stated for hypothesis 5; 100% feedback condition is not beneficial for a failing student.
8. Certainty ratings for future performance will be higher for group 3 (0%) than group 2 (25%); (0% > 25%)	Wilcoxon	ns	- does not support Weiner's theory - implies flaw in measurement - implies effect of CAL practice - confounds results of hypothesis 7	- prediction held true to the theory in hypothesis 7 yet does not hold true for the 0% feedback condition - requires further research with improved measurement tool

Table 21 - continued

			- research hypothesis not accepted	- may be CAL administered activities without feedback conditions cause a decrease in certainty ratings due to an external machine being used, further research necessary.
9. Locus of Control has no relationship with any of the dependent variables.	Spearman Rank	ns	- supports Weiner's theory - implies feedback scheduling influence not altered by an individual's Locus of Control - research hypothesis accepted	- psychological construct of Locus of Control will not interact with feedback conditions administered by CAL practices to produce variance in the dependent variables of stability and certainty ratings - CAL practices and associated achievement and performance levels will not be affected by differences in an individual's Locus of Control.

Limitations of the Study

Population. The present study used a sample of twenty-one grade eight urban middle years students. As described in chapter three, the subjects of the sample were pulled from a generally lower academic stream of the school's population. The size of the sample may have affected the level of statistical significance found in the results of the investigation. The academic characteristic of the sample may affect the generalizability of the results. A logical argument would be that the results of this study represent relationships found in a population of grade eight students which have a lower academic level in regards to mathematics.

Academic area. The present study investigated relationships pertaining to one academic subject area. Learning characteristics and relationships found in the area of mathematics may not be the same characteristics incorporated into Language training. Therefore, the findings of this study are limited to an application to mathematics training, specifically basic decimal computations.

Courseware format. The CAL courseware format utilized in this study was that of drill and practice. Relationships between student learning and performance characteristics and CAL methods must be limited to drill and practice applications. It would be unjustified to take a relationship supported by this study's empirical evidence and assume the same relationship would apply to students who are experiencing CAL courseware that uses a tutorial format.

Implications for Future Research

Variability of standard deviations. A component of this study's post hoc analysis reviewed data pertaining to the variability of performance rates and achievement levels related to the feedback groupings. Standard deviations for the two sets of data were reported in Table 7 and Table 9 and graphically represented in Figure 14 and Figure 15. It was the patterns of the data that held implications.

The achievement standard deviations produced a pattern that was expected. As subjects' scores get higher and closer to the perfect score ceiling, variation of scores decreases. Group three's (0%) achievement scores never quite got as high as the other two groups. Therefore their variations remained consistently higher.

Performance data revealed an unexpected pattern. As the experiment progressed performance rates increased and group rates became increasingly variable. Standard deviations for groups one (100%) and three (0%) follow a similar pattern which is a higher level than that of group two's (25%) pattern. It would be expected that group two's (25%) variability rate would be similar to that of the other two sets of subjects.

Questions are raised in the attempt to explain these results. Are they due to the subjects in group two (25%) being more closely matched on the mathematic ability variable used to determine a subject's assignment to an experimental condition? It is true that further examination of the performance data reveals that group two (25%) does not have a single high performing subject. The other two groups do have at least one subject of this nature. This helps to explain the less variable nature of the performance results. But is the pattern due to the matching process? Or is the variation of individual performance rates lessened by the exposure to intermittent feedback? If this speculation is true, control of feedback schedules may enable instructors to lessen the students' individual differences pertaining to performance rates. Or are performance rates directly affected by the perceived stability of causal attributions made by the subjects regarding their performance?

It is understood by the author that this speculation may read too deeply into data which has been determined to be statistically insignificant. However, the questions raised are believed to be valid and of an educational importance. Further study is required to satisfy these notions.

<u>Causal dimension</u>. Russell's (1982) Causal Dimension Scale is composed of three separate measurement components. This study investigated the relationship of the stability component to CAL

practices. The remaining two components of locus and control were not deeply investigated by the present experiment.

Locus. Results pertaining to the locus component (Table 14 and Figure 12) imply a general configuration which supports the idea that causal attributions for progress were perceived as being more internal for group three (0%). Group one's (100%) ratings were slightly below group three's (0%) and followed by group two's (25%) consistently lower rating levels. Is stability related to the locus dimension? Does continual feedback or lack of feedback affect the locus dimension? Does Russell's scale measure the same item on two separate dimensions?

Control. The control component revealed variable data (Table 15 and Figure 12). In essence, group one (100%) and two (25%) reported similar levels of perceived controllability related to causal attributions. Group three's (0%) higher level on this dimension was significantly different from the level of the other two groups. This result does not duplicate the pattern of the stability data. Therefore the results are indicating a different effect. Is the effect indicated a direct result of the feedback manipulation? Do students receiving no feedback believe their progress is more within their control than students receiving outside feedback? By using CAL procedures, are educators developing performance and achievement gains at the expense of an individual's belief that they maintain control over the learning situation?

The question raised concerning Russell's scale do carry direct educational implications regarding the use of CAL practices and the development of possible unwanted extrinsic attitudes. Further research efforts designed to investigate the implied relationships discussed in this study are necessary.

Extinction. Further research must be undertaken to shed light upon the results obtained by this study regarding extinction rates. Results of previous studies were contradicted by the empirical evidence of the present investigation. As previously inquired, are the present results due to a design flaw (too few extinction trials) or are they related to the causal attributions affected by the feedback manipulation? These questions must be addressed in the future.

Replication. A final implication for future research entails the replication of the present study incorporating some methodological refinements. More substantial results may be obtained if a future study employs a larger pool of subjects. Subjects in the separate feedback manipulation groups should not be in the same homeroom grouping during the course of the experiment. The summary page provided to students by the computer at the end of each trial should be intermittently and randomly delivered to members of group two (25%). This may have further effects on the performance rates of subjects. Causal attributions should also be reported by subjects regarding the feedback agent as well as for their progress. It may be beneficial to conduct two consecutive experiments where one set of matched subjects attributes causes for progress while their counterparts in the other experiment attributes causes for feedback procedures.

It is believed by this author that the results furnished by this study are promising. The need for further research activities to substantiate or refute the empirical evidence uncovered by this study is warranted.

Summation

Design principle. The evidence of this study does support the idea that there are some general CAL courseware design principles for drill and practice mathematic computation programs that should be implemented into CAL activities in order to produce effective and motivated student behaviors. Courseware designs should avoid the zero percent (0%) feedback condition when performance and achievement gains are desired. Although it has been shown that mere repetition of a task helps develop skill automaticity, one must keep in mind that the results of this study indicate that the 100 percent (100%) feedback and 25 percent (25%) feedback schedules produce the greatest gains in regards to achievement and performance levels as well as developing skill automaticity. Drill and practice courseware designs and the associated feedback schedules which are to be used in an educational setting should be determined by the characteristics of the individual learner.

Successful student. To increase the performance rate and achievement level of a successful student, a CAL courseware design should commence with moderately difficult questions. The question difficulty would increase as the program progressed. A 100% feedback schedule would be incorporated into the program.

Average student. A CAL program designed to increase performance and achievement levels for an average student would begin with easy to moderately difficult questions. The question difficulty would increase as the program progressed. The program would utilize a 100% feedback schedule during early stages of the activity to help set a "success" self-concept perception in the student. As the difficulty of the questions increased, the feedback schedule would change to a 25% random schedule. This would maintain the previously established performance level while avoiding the development of a "failure" mind set in the student as more mistakes may occur. Such a negative mind set would lead to a performance shut down.

Failure student. The same basic format used for an average student would be used for a failure student. That is, a success mind set must be developed at the beginning of the program (100% feedback) and a failure mind set must be avoided as the difficulty of the questions is increased (25% feedback). The difference in a program designed for this type of student would be the level of question difficulty and the question pacing. Questions with a very low level of difficulty would be used at the beginning of the program. The pace or rate at which the question difficulty shifted upward would be slower for this type of student.

Commercial programs. It is recommended that commercial drill and practice programs should include a feedback schedule option so that teachers can best fit the CAL experience to the needs of the individual learner. Programs should also have a multiple skill option as well.

Future research. It has also been indicated that more research designed to further uncover each CAL characteristic related to student motivation levels must be undertaken.

It has been rewarding for the author to uncover evidence that supports the theory of Bernard Weiner as it is applied to a naturalist school environment using a realistic academic task. It is believed that the answers to many educationally based questions can be best addressed by using a Cognitive-field model.

The present study has been a worthwhile and personally satisfying exercise. It has set the stage for future research doors to be opened either by this author or by other educational researchers. The establishment of sound learning theory principles is a beneficial activity for all of those who are involved in the educational field.

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APPENDIX A	RAW DATA
Table A:	Performance Results
Table B:	Achievement Results
Table C:	Certainty, Locus, Stability, Control and IAR Scale Results
Table D:	Pre-test and Post-test Results

Table A

Raw Data: Performance Results

Triplet Group		Trials															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	46	54	75	70	88	90	107	115	108	108	106	125	114	115	115	120
	2	34	52	48	56	65	73	62	64	62	70	67	84	85	61	62	68
	3	37	47	54	51	59	57	62	63	58	58	57	67	77	72	67	81
2	1	42	55	50	54	51	62	64	64	58	67	62	65	76	74	87	74
	2	54	84	95	66	84	83	77	85	106	89	96	115	117	129	128	116
	3	43	59	77	88	96	92	109	115	119	119	126	126	127	135	131	134
3	1	55	84	77	89	111	120	126	127	134	134	133	146	159	143	143	143
	2	35	34	40	36	52	55	64	64	73	64	66	87	67	80	92	74
	3	28	27	43	39	40	37	43	43	46	51	44	52	49	62	49	30
4	1	35	49	61	54	41	52	52	67	65	62	64	78	76	83	91	72
	2	46	61	70	70	72	73	84	94	99	88	97	99	101	103	97	82
	3	43	61	57	52	49	66	58	60	68	65	61	70	45	50	72	66
5	1	40	59	64	53	48	67	74	61	75	74	55	86	91	94	102	68
	2	51	52	60	69	85	57	70	79	81	58	77	82	107	84	96	71
	3	28	39	48	51	41	58	51	56	53	56	56	61	53	52	55	49
6	1	28	57	70	57	63	65	62	74	84	83	66	74	85	78	91	93
	2	25	39	40	39	47	44	49	50	51	50	49	61	59	61	72	57
	3	44	55	60	75	74	60	67	78	78	76	79	76	76	63	52	88

Table A (cont'd...)

Triplet Group		Trials															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	1	54	62	67	43	44	54	57	50	52	50	53	51	58	54	50	44
7	2	43	50	58	40	46	47	59	60	66	55	52	66	69	79	64	69
	3	29	40	47	39	36	32	32	40	40	36	34	25	29	28	27	37

Note. Performance data indicates the number of questions attempted during each 10 minute trial.

Table B

Raw Data: Achievement Results

Triplet Group		Trials															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	100	94	95	94	99	99	100	100	98	98	98	99	98	99	100	98
	2	88	92	98	100	98	97	100	100	97	100	94	98	92	92	95	99
	3	68	87	93	84	71	75	85	95	97	95	93	90	97	97	100	100
2	1	93	75	74	94	90	95	98	97	97	96	98	98	95	96	99	97
	2	91	82	82	88	95	95	95	95	100	98	92	95	97	98	98	116
	3	100	100	94	96	93	93	98	98	98	99	98	98	100	99	100	99
3	1	95	94	96	96	100	98	95	96	99	98	97	98	97	87	96	97
	2	89	62	83	94	96	91	97	84	86	97	85	94	93	86	88	86
	3	68	67	91	97	98	100	95	100	98	98	93	98	100	87	96	100
4	1	97	88	95	89	90	100	94	99	92	98	98	99	99	94	98	99
	2	85	72	84	83	85	90	93	90	96	90	94	94	93	90	95	88
	3	74	69	82	83	80	71	76	72	90	85	77	73	89	92	93	94
5	1	100	73	74	87	98	94	97	100	95	100	95	93	96	96	93	94
	2	82	71	77	88	94	88	83	96	100	97	94	96	99	94	96	90
	3	89	95	96	98	100	89	94	93	96	95	93	100	100	98	100	96
6	1	96	95	84	93	87	94	98	97	100	99	88	98	95	92	98	98
	2	80	67	70	90	83	84	92	96	92	94	94	98	97	90	93	93
	3	80	71	73	75	84	75	76	81	82	82	78	72	70	73	77	78

Table B (cont'd...)

Triplet Group		Trials 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7	1	54	48	46	51	75	80	98	96	96	94	98	88	93	100	96	87
	2	49	46	55	60	65	74	93	13	89	89	96	94	91	89	91	87
	3	86	83	60	72	75	78	88	78	73	78	74	100	97	86	81	95

Note. Achievement data reported as a percentage correct on questions attempted.

Table C

Raw Data: Certainty, Locus, Stability, Control and IAR Scale Results

Group	n	Certainty(10) 1	2	3	4	Locus(27) 1	2	3	4	Stability(27) 1	2	3	4	Control(27) 1	2	3	4	IAR(34)
	1	4	10	7	7	15	27	27	27	14	13	19	11	27	11	11	19	24
	2	7	10	9	9	22	23	22	22	12	19	21	20	20	17	17	21	27
	3	8	10	10	10	17	18	25	25	18	24	25	21	23	10	4	5	24
1	4	7	9	8	8	19	18	15	15	8	12	12	10	18	17	13	14	27
	5	5	8	9	10	23	19	19	21	13	14	7	12	14	22	18	25	31
	6	7	9	9	7	20	23	19	20	13	15	16	17	27	26	26	25	20
	7	4	9	8	8	15	24	20	22	9	20	19	18	13	23	20	19	28
	1	7	8	5	4	15	10	18	23	12	5	3	3	15	10	19	12	23
	2	6	8	7	7	18	17	20	21	15	12	19	20	18	16	18	19	17
	3	7	7	6	7	22	21	17	18	15	15	15	14	23	21	20	21	26
2	4	5	8	9	9	19	16	15	16	14	12	15	12	21	18	23	16	30
	5	5	10	10	9	13	15	19	18	5	14	11	10	18	18	20	18	28
	6	6	7	6	6	15	21	18	19	4	7	5	3	5	6	9	5	20
	7	0	7	8	8	18	19	21	14	22	17	12	16	11	19	12	14	30
	1	3	7	5	5	22	21	22	19	9	14	11	12	14	11	16	14	29
	2	8	9	9	9	24	23	25	22	22	27	26	27	18	16	22	22	25
	3	8	9	10	9	12	27	25	26	3	17	17	19	25	27	27	19	27
3	4	4	4	7	8	26	26	26	25	23	15	10	11	19	11	24	21	27
	5	7	9	9	9	19	19	19	16	7	21	25	25	21	20	25	27	27
	6	6	3	9	10	20	22	25	25	10	4	6	3	22	27	27	27	26
	7	4	7	7	7	11	18	19	11	18	21	13	11	20	14	27	23	18

Note. Figures in brackets represent total possible points for each scale.

Table D

Raw Data: Pre-Test and Post-Test Results

Group	n	Pre-Test (%)	Post-Test (%)
	1	100	98
	2	98	100
	3	94	100
1	4	94	100
	5	82	100
	6	74	98
	7	44	98
	1	100	100
	2	98	98
	3	98	94
2	4	94	100
	5	90	98
	6	80	94
	7	58	90
	1	100	100
	2	98	100
	3	96	96
3	4	92	100
	5	92	98
	6	68	78
	7	48	90

APPENDIX B: LISTING OF THE DECIMAL COMPUTER PROGRAM

```
 LOAD MM
]LIST

 100  DIM CH%(128)
 102  REM   ONERR GOTO 20000
 104  GOSUB 9000: GOSUB 15000: GOSUB
     16000
 106  GOSUB 9000: VTAB 4: PRINT "
     Choose the kind of feedback.
     "
 108 MN$(1) = " Immediate feedbac
     k "
 110 MN$(2) = " Delayed feedback
     of 5 seconds "
 112 MN$(3) = " Immediate feedbac
     k (25% of the time) "
 114 MN$(4) = " Delayed feedback
     (25% of the time) "
 116 MN$(5) = " No feedback "
 118 MN = 5: GOSUB 11000: IF ESC =
     1 THEN 106
 119 F$ = "PRG." +  STR$ (R)
 120  GOSUB 9000: VTAB 4: PRINT "
     Choose the level of difficul
     ty."
 122 MN$(1) = " Level 1 "
 124 MN$(2) = " Level 2 "
 126 MN = 2: GOSUB 11000: IF ESC =
     1 THEN 106
 127 F$ = F$ +  STR$ (R)
 128  GOSUB 9000: VTAB 12: PRINT
     "One moment please.": PRINT

 130  PRINT  CHR$ (4)"RUN";F$
 9000  HOME : CALL  - 3086: RETURN

 10000  REM   SPACE BAR
 10030  VTAB 24: HTAB 1: GOSUB 12
     500: HTAB 5: PRINT "Press [S
     PACE BAR] to continue.";:
 10040  POKE 49168,0
 10050 KY =  PEEK (49152): IF KY <
     128 THEN 10050
 10060  POKE 49168,0: IF (KY <  >
     160) AND (KY <  > 155) THEN
     10050
 10070 ESC = (KY = 155): HTAB 1: GOSUB
     12500: RETURN
 11000 ESC = 0: REM   MENU
 11030  PRINT :SP = 1 + (MN < 8):
     R = 1:ML =  LEN (MN$(1)): FOR
     I = 2 TO MN: IF  LEN (MN$(I)
     ) > ML THEN ML =  LEN (MN$(I
     ))
```

```
11040  NEXT I:ML =  INT ((40 - M
    L) / 2):CV =  PEEK (37): FOR
    I = 1 TO MN: VTAB (SP * I +
    CV): HTAB (ML): PRINT MN$(I)
    : NEXT I: VTAB 23: HTAB 2: PRINT
    "[SPACE BAR] moves, [RETURN]
     selects.": IF R = 0 THEN R =
    1
11050  POKE 49168,0
11060  IF R < 1 THEN R = MN
11070  IF R > MN THEN R = 1
11080  VTAB (SP * R + CV): HTAB
    (ML): INVERSE : PRINT MN$(R)
    ;: NORMAL
11090 KY =  PEEK ( - 16384): IF
    KY < 128 THEN 11090
11100  POKE 49168,0: IF KY = 139
     OR KY = 136 THEN  GOSUB 111
    40:R = R - 1
11110  IF KY = 138 OR KY = 160 OR
    KY = 149 THEN  GOSUB 11140:R
     = R + 1
11120  IF KY = 141 THEN  RETURN

11125  IF KY = 155 THEN ESC = 1:
     RETURN
11130  GOTO 11060
11140  VTAB (SP * R + CV): HTAB
    (ML): PRINT MN$(R): RETURN
12000  CALL  - 3086: HTAB 1: VTAB
    1: RETURN
12500  HTAB 1: VTAB 24: PRINT  SPC(
    40);: VTAB 24: HTAB 1: RETURN

14000  REM  INPUT
14030 ESC = 0
14040 CH%(8) = 0:CH%(127) = 0:IN
    $ = "":I = 10: POKE 49168,0
14050 I = I + 1 - (I > 10) * 20:
     PRINT  CHR$ (95 - (I > 6) *
    63);" ";: CALL  - 1008: CALL
     - 1008:KY% =  PEEK (49152):
     IF KY% < 128 THEN 14050
14060  POKE 49168,0:KY% = KY% -
    128: IF CH%(KY%) = 0 THEN 14
    050
14070  ON CH%(KY%) GOTO 14080,14
    100,14120,14130
14080  IF LN% >  LEN (IN$) THEN
    IN$ = IN$ +  CHR$ (KY% - 32 *
    (CH%(KY%) = 5)):CH%(8) = 2:C
    H%(127) = 2: PRINT  CHR$ (KY
    %);
14090  IF IN$ <  > " " THEN 1405
    0
14100  IF  LEN (IN$) = 1 THEN IN
    $ = "": CALL  - 1008:CH%(8) =
    0:CH%(127) = 0: GOTO 14050
```

```
14110 IN$ =  LEFT$ (IN$, LEN (IN
    $) - 1): CALL  - 1008: GOTO
    14050
14120 ESC = 1: GOTO 14140
14130  IF IN$ = "" THEN 14050
14140  PRINT " ";: RETURN
15000  REM  INITS FOR CH%
15040  FOR T = 1 TO 128:CH%(T) =
    0: NEXT
15050  FOR T = 65 TO 90:CH%(T) =
    1:CH%(T + 32) = 5: NEXT
15060 CH%(13) = 4:CH%(8) = 2:CH%
    (127) = 2
15070  RETURN
16000  REM  NAME GET
16060 LN% = 10:CH%(32) = 0:CH%(4
    6) = 0:CH%(27) = 0: VTAB 10:
     PRINT "Please type your fir
    st name.": PRINT : PRINT "Th
    en press [RETURN].": PRINT :
     PRINT "> ";: GOSUB 14000: IF
    ESC THEN ESC = 0: GOTO 16050

16070  GOSUB 16080:CH%(32) = 1:C
    H%(27) = 3:CH%(46) = 1: RETURN

16080 NA$ = "":B1$ =  LEFT$ (IN$
    ,1):C =  ASC ( LEFT$ (IN$,1)
    ): IF C > 90 THEN C = C - 32
    :B1$ =  CHR$ (C)
16090 NA$ = NA$ + B1$: IF  LEN (
    IN$) < 2 THEN 16120
16100  FOR C = 2 TO  LEN (IN$):C
    1 =  ASC ( MID$ (IN$,C,1)):B
    1$ =  CHR$ (C1): IF C1 < 90 AND
    C1 <  > 32 THEN C1 = C1 + 32
    :B1$ =  CHR$ (C1)
16110 NA$ = NA$ + B1$: NEXT
16120  HTAB 3: VTAB 14: PRINT NA
    $:L =  LEN (NA$): POKE 33000
    ,L: FOR C = 1 TO L: POKE 330
    00 + C, ASC ( MID$ (NA$,C,1)
    ): NEXT : RETURN
20000  CALL  - 1370
```

```
]LOAD PRG.11
]LIST

 0  GOTO 5: REM  PRG.11 - immedia
     te - easy
 1 TM = TM + CT: IF TM > DD THEN
     MN = MN + N1:TM = NO
 2  IF MN = N9 THEN 24000
 3  RETURN
 5  ONERR  GOTO 26000
 6  DIM FD$(14),CH%(127): SCALE=
     1: ROT= 0: HCOLOR= 3
 7  GOSUB 17000: GOSUB 18000: GOSUB
     16000
 8  PRINT  CHR$ (4)"BLOAD SCREEN,
     A8192"
 9  VTAB N5: HTAB N4: PRINT "Pres
     s [RETURN] after the answer.
     ": VTAB N7: HTAB N4: PRINT "
     Use [DELETE] to erase your a
     nswer.": VTAB N9: HTAB N4: PRINT
     "The clock starts next page.
     "
10  GOSUB 950: FOR I = N5 TO N9:
     VTAB I: HTAB N3: PRINT W$(O
     ): NEXT
12  GOSUB 250:X = 115:Y = 77: GOSUB
     200: GOSUB 240:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
13  GOSUB 260:X = 115:Y = 77: GOSUB
     200: GOSUB 240:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
14  GOSUB 270:X = 115:Y = 77: GOSUB
     200: GOSUB 240:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
15 PP =  FRE (NO): GOTO 12
99 NG =  INT ( RND ( RND ( PEEK
     (78))) * LU + LW):NG$ =  STR$
     (NG): RETURN
100  HCOLOR= N3:EN =  LEN (DS$):
     FOR I = N1 TO EN:C$ =  MID$
     (DS$,I,1): IF C$ = DOT$ THEN
     102
101 SH =  VAL (C$) + N1: DRAW SH
     AT X,Y:X = X + T8: GOTO 103

102 SH = T4: DRAW SH AT X - N4,Y
     + N4:X = X + TO
103  NEXT
104  RETURN
110 ST = ST + N1: HCOLOR= NO: IF
     CC = NO THEN  DRAW T5 AT X,Y
```

```
111 XX(ST) = X:YY(ST) = Y: IF C$
     = DOT$ THEN IN(ST) = T4:RT =
    T4:DW = N4:X = X - N4:XX(ST)
     = X:CH%(46) = NO: GOTO 114
112 IN(ST) =  VAL (C$) + N1:RT =
    T8:DW = NO
114  HCOLOR= N3: DRAW IN(ST) AT
    X,Y + DW:X = X + RT:YY(ST) =
    Y + DW: RETURN
120  FOR J = V1 TO V2: VTAB J: HTAB
    H: PRINT W$(JJ): NEXT : RETURN

130  HPLOT 93,71 TO 181,71: HPLOT
    93,72 TO 181,72: RETURN
140 CT = QT: POKE RS,NO: VTAB W3
    : HTAB N3: PRINT "[SPACE BAR
    ] gets the next question."
141 KY =  PEEK (KB): GOSUB 1: IF
    KY < LM THEN 141
142  POKE RS,NO: IF KY <  > SB THEN
    141
143  VTAB W3: HTAB N3: PRINT W$(
    0): RETURN
150  IF  LEN (AN$) < N5 THEN  RETURN

151 XP = NO: FOR XJ = N1 TO  LEN
    (AN$): IF  MID$ (AN$,XJ,N1) =
    DOT$ THEN XP = XJ: GOTO 153
152  NEXT
153 AN$ =  LEFT$ (AN$,XP + N3):E
    D =  LEN (AN$):AN =  VAL (AN
    $) + AS:AN$ =  LEFT$ ( STR$
    (AN),ED - N1)
154  RETURN
200 CH%(46) = N1:K = NO:CT = N1:
    CH%(127) = NO:IN$ = "":ST =
    NO: POKE RS,NO:CC = N3
201 K = K + N1: IF K > T2 THEN  HCOLOR=
    3 - (CC = N3) * N3
202 KY% =  PEEK (KB): GOSUB 1: IF
    KY% < LM THEN 201
203  POKE RS,NO:KY% = KY% - LM: IF
    CH%(KY%) = NO THEN 201
204  ON CH%(KY%) GOTO 205,207,20
    1,211
205  IF LN% >  LEN (IN$) THEN C$
     =  CHR$ (KY%):IN$ = IN$ + C
    $:CH%(127) = N2: GOSUB 110
206  GOTO 201
207  IF  LEN (IN$) = N1 THEN IN$
     = "":CH%(127) = NO: GOTO 20
    9
208 IN$ =  LEFT$ (IN$, LEN (IN$)
     - N1)
```

```
209  HCOLOR= NO: DRAW T5 AT X,Y:
      DRAW IN(ST) AT XX(ST),YY(ST
     ):X = XX(ST):Y = YY(ST):ST =
     ST - N1:TM = TM + N8: IF IN(
     ST + N1) = T4 THEN Y = Y - N
     4:CH%(46) = N1
210  GOTO 201
211  IF IN$ = "" THEN 201
212  HCOLOR= NO: DRAW T5 AT X,Y
213  RETURN
240 RT = NO:LW = TO:LU = N5: IF
      ABS ( VAL (AN$) -  VAL (IN$
     )) < SW THEN LW = NO:LU = TO
     :RT = N1
241  GOSUB 99: VTAB T9: HTAB N3:
      PRINT FD$(NG);" ";NA$: IF N
     G < TO THEN 244
242  VTAB W1: HTAB N3: PRINT "Th
     e correct answer is ";AN$
244  ON OP GOTO 245,246,247
245 AQ = AQ + N1:AC = AC + RT: GOTO
     248.
246 SQ = SQ + N1:SC = SC + RT: GOTO
     248
247 MQ = MQ + N1:MC = MC + RT
248  GOSUB 140:V1 = T9:V2 = W1:H
      = N3:JJ = NO: GOSUB 120: RETURN

250 OP = N1
251 LW = N1:LU = N9: GOSUB 99:TP
      = NG / TO:DS$ = Z$ +  STR$
     (TP):X = 115:Y = 30: GOSUB 1
     00
252 LW = N1:LU = 99: GOSUB 99:BT
      = NG / HU:DS$ = Z$ +  STR$
     (BT): DRAW T1 AT 98,50:X = 1
     15:Y = 50: GOSUB 100
253 AN = TP + BT:AN$ =  STR$ (AN
     ): GOSUB 150: GOSUB 130: RETURN

260 OP = N2
261 LW = N2:LU = N8: GOSUB 99:TP
      = NG / TO:DS$ = Z$ +  STR$
     (TP):X = 115:Y = 30: GOSUB 1
     00
262 LW = N1:LU = TP * HU - N1: GOSUB
     99:BT = NG / HU:DS$ = Z$ +  STR$
     (BT): DRAW T2 AT 98,50:X = 1
     15:Y = 50: GOSUB 100
263 AN = TP - BT:AN$ =  STR$ (AN
     ): GOSUB 150: GOSUB 130: RETURN

270 OP = N3
271 LW = N1:LU = N9: GOSUB 99:TP
      = NG / TO:DS$ = Z$ +  STR$
     (TP):X = 115:Y = 30: GOSUB 1
     00
```

```
272  GOSUB 99:BT = NG:LW = N1:LU
     = N2: GOSUB 99: ON NG GOTO
    273,274
273 BT = BT / TO:DS$ = Z$ +  STR$
    (BT):X = 115: GOTO 275
274 DS$ =  STR$ (BT):X = 143
275  DRAW T3 AT 98,50:Y = 50: GOSUB
    100
276 AN = TP * BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

950  POKE RS,NO: VTAB 22: HTAB N
    6: PRINT "Press [SPACE BAR]
    to continue."
951 KY =  PEEK (KB): IF KY < LM THEN
    951
952  POKE RS,NO: IF KY <  > SB THEN
    951
953  VTAB 22: HTAB N3: PRINT W$(
    0): RETURN
16000  FOR T = 1 TO 127:CH%(T) =
    NO: NEXT :CH%(13) = N4
16001  FOR T = 48 TO 57:CH%(T) =
    N1: NEXT :LN% = N6:CH%(46) =
    N1
16002  RETURN
17000 NO = 0:N1 = 1:N2 = 2:N3 =
    3:N4 = 4:N5 = 5:N6 = 6:N7 =
    7:N8 = 8:N9 = 9:TO = 10:T1 =
    11:T2 = 12:T3 = 13:T4 = 14:L
    M = 128:RS = 49168:KB = 4915
    2:W7 = 39.5
17001  FOR I = 0 TO 14: READ FD$
    (I): NEXT :MN = 0:DD = 1630:
    TM = 0:CT = 0:SB = 160:AC =
    0:AQ = 0:SC = 0:SQ = 0:MC =
    0:MQ = 0:HU = 100:T8 = 18:T6
     = 16:T5 = 15:T9 = 19:W1 = 2
    1:W3 = 23:QT = .6
17002 W$(0) = "
                              ":DOT$ =
    ".":W$(1) = "
          ":SW = .0000001:Z$ = "
    0":AS = .002
17010  RETURN
18000 L =  PEEK (33000):NA$ = ""
    : FOR C = N1 TO L:NA$ = NA$ +
     CHR$ ( PEEK (33000 + C)): NEXT
    : RETURN
24000  PRINT  CHR$ (7): HOME : CALL
     - 3086: VTAB 7: HTAB 17: PRINT
    "Summary":TQ = AQ + SQ + MQ:
    TC = AC + SC + MC: PRINT
24020  PRINT : PRINT "Number of
    questions tried:";: HTAB 29:
     PRINT TQ
```

```
 24030  PRINT : PRINT "Number of
     correct answers:";: HTAB 29:
      PRINT TC
 24031  PRINT : IF TQ > NO THEN  PRINT
     "Percent correct:";: HTAB 29
     : PRINT  INT ((TC / TQ) * 10
     0 + .5);"%"
 24040  REM
 24050  GOTO 24040
 26000  CALL  - 1370
 30000  DATA  "Yes, that is corre
     ct,"
 30001  DATA  "Good thinking,"
 30002  DATA  "Keep up the good w
     ork,"
 30003  DATA  "Nice going,"
 30004  DATA  "That is correct,"
 30005  DATA  "Correct,"
 30006  DATA  "Nice work,"
 30007  DATA  "Good choice,"
 30008  DATA  "You're right,"
 30009  DATA  "That's right,"
 30010  DATA  "No, that is incorr
     ect,"
 30011  DATA  "Wrong choice,"
 30012  DATA  "Sorry,"
 30013  DATA  "Incorrect,"
 30014  DATA  "You are incorrect,
     "
```

```
]LOAD PRG.31
]LIST

 0  GOTO 5: REM  PRG.31 - immedia
     te (25%) - easy
 1 TM = TM + CT: IF TM > DD THEN
     MN = MN + N1:TM = NO
 2  IF MN = N9 THEN 25000
 3  RETURN
 5  ONERR  GOTO 26000
 6  DIM FD$(14),CH%(127): SCALE=
     1: ROT= 0: HCOLOR= 3
 7  GOSUB 17000: GOSUB 18000: GOSUB
     16000
 8  PRINT  CHR$ (4)"BLOAD SCREEN,
     A8192"
 9  VTAB N5: HTAB N4: PRINT "Pres
     s [RETURN] after the answer.
     ": VTAB N7: HTAB N4: PRINT "
     Use [DELETE] to erase your a
     nswer.": VTAB N9: HTAB N4: PRINT
     "The clock starts next page.
     "
```

```
10  GOSUB 950: FOR I = N5 TO N9:
     VTAB I: HTAB N3: PRINT W$(0
    ): NEXT
12  GOSUB 250:X = 115:Y = 77: GOSUB
    200: GOSUB 220:CT = W7: GOSUB
    1:JJ = N1:V1 = N4:V2 = T2:H =
    T4: GOSUB 120
13  GOSUB 260:X = 115:Y = 77: GOSUB
    200: GOSUB 220:CT = W7: GOSUB
    1:JJ = N1:V1 = N4:V2 = T2:H =
    T4: GOSUB 120
14  GOSUB 270:X = 115:Y = 77: GOSUB
    200: GOSUB 220:CT = W7: GOSUB
    1:JJ = N1:V1 = N4:V2 = T2:H =
    T4: GOSUB 120
15 PP =  FRE (NO): GOTO 12
99 NG =  INT ( RND ( RND ( PEEK
    (78))) * LU + LW):NG$ =  STR$
    (NG): RETURN
100  HCOLOR= N3:EN =  LEN (DS$):
     FOR I = N1 TO EN:C$ =  MID$
    (DS$,I,1): IF C$ = DOT$ THEN
    102
101 SH =  VAL (C$) + N1: DRAW SH
     AT X,Y:X = X + T8: GOTO 103

102 SH = T4: DRAW SH AT X - N4,Y
     + N4:X = X + TO
103  NEXT
104  RETURN
110 ST = ST + N1: HCOLOR= NO: IF
    CC = NO THEN  DRAW T5 AT X,Y

111 XX(ST) = X:YY(ST) = Y: IF C$
     = DOT$ THEN IN(ST) = T4:RT =
    T4:DW = N4:X = X - N4:XX(ST)
     = X:CH%(46) = NO: GOTO 114
112 IN(ST) =  VAL (C$) + N1:RT =
    T8:DW = NO
114  HCOLOR= N3: DRAW IN(ST) AT
    X,Y + DW:X = X + RT:YY(ST) =
    Y + DW: RETURN
120  FOR J = V1 TO V2: VTAB J: HTAB
    H: PRINT W$(JJ): NEXT : RETURN

130  HPLOT 93,71 TO 181,71: HPLOT
    93,72 TO 181,72: RETURN
140 CT = QT: POKE RS,NO: VTAB W3
    : HTAB N3: PRINT "[SPACE BAR
    ] gets the next question."
141 KY =  PEEK (KB): GOSUB 1: IF
    KY < LM THEN 141
142  POKE RS,NO: IF KY <  > SB THEN
    141
143  VTAB W3: HTAB N3: PRINT W$(
    0): RETURN
150  IF  LEN (AN$) < N5 THEN  RETURN
```

```
151 XP = NO: FOR XJ = N1 TO  LEN
    (AN$): IF  MID$ (AN$,XJ,N1) =
    DOT$ THEN XP = XJ: GOTO 153
152  NEXT
153 AN$ =  LEFT$ (AN$,XP + N3):E
    D =  LEN (AN$):AN =  VAL (AN
    $) + AS:AN$ =  LEFT$ ( STR$
    (AN),ED - N1)
154  RETURN
200 CH%(46) = N1:K = NO:CT = N1:
    CH%(127) = NO:IN$ = "":ST =
    NO: POKE RS,NO:CC = N3
201 K = K + N1: IF K > T2 THEN  HCOLOR=
    3 - (CC = N3) * N3
202 KY% =  PEEK (KB): GOSUB 1: IF
    KY% < LM THEN 201
203  POKE RS,NO:KY% = KY% - LM: IF
    CH%(KY%) = NO THEN 201
204  ON CH%(KY%) GOTO 205,207,20
    1,211
205  IF LN% >  LEN (IN$) THEN C$
     =  CHR$ (KY%):IN$ = IN$ + C
    $:CH%(127) = N2: GOSUB 110
206  GOTO 201
207  IF  LEN (IN$) = N1 THEN IN$
     = "":CH%(127) = NO: GOTO 20
    9
208 IN$ =  LEFT$ (IN$, LEN (IN$)
     - N1)
209  HCOLOR= NO: DRAW T5 AT X,Y:
     DRAW IN(ST) AT XX(ST),YY(ST
    ):X = XX(ST):Y = YY(ST):ST =
    ST - N1:TM = TM + N3: IF IN(
    ST + N1) = T4 THEN Y = Y - N
    4:CH%(46) = N1
210  GOTO 201
211  IF IN$ = "" THEN 201
212  HCOLOR= NO: DRAW T5 AT X,Y
213  RETURN
220 RT = NO:LW = TO:LU = N5: IF
     ABS ( VAL (AN$) -  VAL (IN$
    )) < SW THEN LW = NO:LU = TO
    :RT = N1
221  GOSUB 99:AB = NG:LW = N1:LU
     = N4: GOSUB 99: IF NG <  >
    N4 THEN 224
222  VTAB T9: HTAB N3: PRINT FD$
    (AB);" ";NA$: IF AB < TO THEN
    224
223  VTAB W1: HTAB N3: PRINT "Th
    e correct answer is ";AN$
224  ON OP GOTO 225,226,227
225 AQ = AQ + N1:AC = AC + RT: GOTO
    228
226 SQ = SQ + N1:SC = SC + RT: GOTO
    228
227 MQ = MQ + N1:MC = MC + RT
228  GOSUB 140:V1 = T9:V2 = W1:H
     = N3:JJ = NO: GOSUB 120: RETURN
```

```
250 OP = N1
251 LW = N1:LU = N9: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
252 LW = N1:LU = 99: GOSUB 99:BT
     = NG / HU:DS$ = Z$ +  STR$
    (BT): DRAW T1 AT 98,50:X = 1
    15:Y = 50: GOSUB 100
253 AN = TP + BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

260 OP = N2
261 LW = N2:LU = N8: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
262 LW = N1:LU = TP * HU - N1: GOSUB
    99:BT = NG / HU:DS$ = Z$ +  STR$
    (BT): DRAW T2 AT 98,50:X = 1
    15:Y = 50: GOSUB 100
263 AN = TP - BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

270 OP = N3
271 LW = N1:LU = N9: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
272  GOSUB 99:BT = NG:LW = N1:LU
     = N2: GOSUB 99: ON NG GOTO
    273,274
273 BT = BT / TO:DS$ = Z$ +  STR$
    (BT):X = 115: GOTO 275
274 DS$ =  STR$ (BT):X = 143
275  DRAW T3 AT 98,50:Y = 50: GOSUB
    100
276 AN = TP * BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

950  POKE RS,NO: VTAB 22: HTAB N
    6: PRINT "Press [SPACE BAR]
    to continue."
951 KY =  PEEK (KB): IF KY < LM THEN
    951
952  POKE RS,NO: IF KY <  > SB THEN
    951
953  VTAB 22: HTAB N3: PRINT W$(
    0): RETURN
16000  FOR T = 1 TO 127:CH%(T) =
    NO: NEXT :CH%(13) = N4
16001  FOR T = 48 TO 57:CH%(T) =
    N1: NEXT :LN% = N6:CH%(46) =
    N1
16002  RETURN
17000 NO = 0:N1 = 1:N2 = 2:N3 =
    3:N4 = 4:N5 = 5:N6 = 6:N7 =
    7:N8 = 8:N9 = 9:TO = 10:T1 =
    11:T2 = 12:T3 = 13:T4 = 14:L
    M = 128:RS = 49168:KB = 4915
    2:W7 = 39.5
```

```
17001  FOR I = 0 TO 14: READ FD$
     (I): NEXT :MN = 0:DD = 1630:
     TM = 0:CT = 0:SB = 160:AC =
     0:AQ = 0:SC = 0:SQ = 0:MC =
     0:MQ = 0:HU = 100:T8 = 18:T6
      = 16:T5 = 15:T9 = 19:W1 = 2
     1:W3 = 23:QT = .6
17002 W$(0) = "
                              ":DOT$ =
     ".":W$(1) = "
           ":SW = .0000001:Z$ = "
     0":AS = .002
17010  RETURN
18000 L =  PEEK (33000):NA$ = ""
     : FOR C = N1 TO L:NA$ = NA$ +
      CHR$ ( PEEK (33000 + C)): NEXT
     : RETURN
25000  PRINT  CHR$ (7): HOME : CALL
      - 3086: VTAB 7: HTAB 17: PRINT
     "Summary": PRINT
25010 TQ = AQ + SQ + MQ:TC = AC +
     SC + MC
25020  PRINT : PRINT "Number of
     questions tried:";: HTAB 29:
      PRINT TQ
25030  PRINT : PRINT "Number of
     correct answers:";: HTAB 29:
      PRINT TC
25031  PRINT : IF TQ > NO THEN  PRINT
     "Percent correct:";: HTAB 29
     : PRINT  INT ((TC / TQ) * 10
     0 + .5);"%".
25060  REM
25062  GOTO 25060
26000  CALL  - 1370
30000  DATA  "Yes, that is corre
     ct,"
30001  DATA  "Good thinking,"
30002  DATA  "Keep up the good w
     ork,"
30003  DATA  "Nice going,"
30004  DATA  "That is correct,"
30005  DATA  "Correct,"
30006  DATA  "Nice work,"
30007  DATA  "Good choice,"
30008  DATA  "You're right,"
30009  DATA  "That's right,"
30010  DATA  "No, that is incorr
     ect,"
30011  DATA  "Wrong choice,"
30012  DATA  "Sorry,"
30013  DATA  "Incorrect,"
30014  DATA  "You are incorrect,
     "
```

```
]LOAD PRG.51
]LIST

 0  GOTO 5: REM  PRG.51 - NO FEED
     BACK - easy
 1 TM = TM + CT: IF TM > DD THEN
     MN = MN + N1:TM = NO
 2  IF MN = N9 THEN  POP : GOTO 2
     5000
 3  RETURN
 5  REM   ONERR  GOTO 26000
 6  DIM FD$(14),CH%(127): SCALE=
     1: ROT= 0: HCOLOR= 3
 7  GOSUB 17000: GOSUB 18000: GOSUB
     16000
 8  PRINT  CHR$ (4)"BLOAD SCREEN,
     A8192"
 9  VTAB N5: HTAB N4: PRINT "Pres
     s [RETURN] after the answer.
     ": VTAB N7: HTAB N4: PRINT "
     Use [DELETE] to erase your a
     nswer.": VTAB N9: HTAB N4: PRINT
     "The clock starts next page.
     "
 10  GOSUB 950: FOR I = N5 TO N9:
      VTAB I: HTAB N3: PRINT W$(0
     ): NEXT :QQ = NO
 12  GOSUB 250:X = 115:Y = 75: GOSUB
     200: GOSUB 220:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
 13  GOSUB 260:X = 115:Y = 75: GOSUB
     200: GOSUB 220:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
 14  GOSUB 270:X = 115:Y = 75: GOSUB
     200: GOSUB 220:CT = W7: GOSUB
     1:JJ = N1:V1 = N4:V2 = T2:H =
     T4: GOSUB 120
 15 PP =  FRE (NO): GOTO 12
 99 NG =  INT ( RND ( RND ( PEEK
     (78))) * LU + LW):NG$ =  STR$
     (NG): RETURN
 100  HCOLOR= N3:EN =  LEN (DS$):
      FOR I = N1 TO EN:C$ =  MID$
     (DS$,I,1): IF C$ = DOT$ THEN
     102
 101 SH =  VAL (C$) + N1: DRAW SH
      AT X,Y:X = X + T8: GOTO 103

 102 SH = T4: DRAW SH AT X - N4,Y
      + N4:X = X + TO
 103  NEXT
 104  RETURN
 110 ST = ST + N1: HCOLOR= NO: IF
     CC = NO THEN  DRAW T5 AT X,Y
```

```
111 XX(ST) = X:YY(ST) = Y: IF C$
     = DOT$ THEN IN(ST) = T4:RT =
    T4:DW = N4:X = X - N4:XX(ST)
     = X:CH%(46) = NO: GOTO 114
112 IN(ST) =  VAL (C$) + N1:RT =
    T8:DW = NO
114  HCOLOR= N3: DRAW IN(ST) AT
    X,Y + DW:X = X + RT:YY(ST) =
    Y + DW: RETURN
120  FOR J = V1 TO V2: VTAB J: HTAB
    H: PRINT W$(JJ): NEXT : RETURN

130  HPLOT 93,71 TO 181,71: HPLOT
    93,72 TO 181,72: RETURN
140 CT = QT: POKE RS,NO: VTAB W1
    : HTAB N3: PRINT "[SPACE BAR
    ] gets the next question."
141 KY =  PEEK (KB): GOSUB 1: IF
    KY < LM THEN 141
142  POKE RS,NO: IF KY <  > SB THEN
    141
143  VTAB W1: HTAB N3: PRINT W$(
    0): RETURN
150  IF  LEN (AN$) < N5 THEN  RETURN

151 XP = NO: FOR XJ = N1 TO  LEN
    (AN$): IF  MID$ (AN$,XJ,N1) =
    DOT$ THEN XP = XJ: GOTO 153
152  NEXT
153 AN$ =  LEFT$ (AN$,XP + N3):E
    D =  LEN (AN$):AN =  VAL (AN
    $) + AS:AN$ =  LEFT$ ( STR$
    (AN),ED - N1)
154  RETURN
200 CH%(46) = N1:K = NO:CT = N1:
    CH%(127) = NO:IN$ = "":ST =
    NO: POKE RS,NO:CC = N3
201 K = K + N1: IF K > T2 THEN  HCOLOR
    3 - (CC = N3) * N3
202 KY% =  PEEK (KB): GOSUB 1: IF
    KY% < LM THEN 201
203  POKE RS,NO:KY% = KY% - LM: IF
    CH%(KY%) = NO THEN 201
204  ON CH%(KY%) GOTO 205,207,20
    1,211
205  IF LN% >  LEN (IN$) THEN C$
     =  CHR$ (KY%):IN$ = IN$ + C
    $:CH%(127) = N2: GOSUB 110
206  GOTO 201
207  IF  LEN (IN$) = N1 THEN IN$
     = "":CH%(127) = NO: GOTO 20
    9
208 IN$ =  LEFT$ (IN$, LEN (IN$)
     - N1)
209  HCOLOR= NO: DRAW T5 AT X,Y:
     DRAW IN(ST) AT XX(ST),YY(ST
    ):X = XX(ST):Y = YY(ST):ST =
    ST - N1:TM = TM + N8: IF IN(
    ST + N1) = T4 THEN Y = Y - N
    4:CH%(46) = N1
```

```
210  GOTO 201
211  IF IN$ = "" THEN 201
212  HCOLOR= NO: DRAW T5 AT X,Y
213  RETURN
220 RT = NO: IF  ABS ( VAL (AN$)
     -  VAL (IN$)) < SW THEN RT =
    N1
221  ON OP GOTO 222,223,224
222 AQ = AQ + N1:AC = AC + RT: GOTO
    225
223 SQ = SQ + N1:SC = SC + RT: GOTO
    225
224 MQ = MQ + N1:MC = MC + RT
225  GOSUB 140: RETURN
250 OP = N1
251 LW = N1:LU = N9: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
252 LW = N1:LU = 99: GOSUB 99:BT
     = NG / HU:DS$ = Z$ +  STR$
    (BT): DRAW T1 AT 98,50:X = 1
    15:Y = 50: GOSUB 100
253 AN = TP + BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

260 OP = N2
261 LW = N2:LU = N8: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
262 LW = N1:LU = TP * HU - N1: GOSUB
    99:BT = NG / HU:DS$ = Z$ +  STR$
    (BT): DRAW T2 AT 98,50:X = 1
    15:Y = 50: GOSUB 100
263 AN = TP - BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

270 OP = N3
271 LW = N1:LU = N9: GOSUB 99:TP
     = NG / TO:DS$ = Z$ +  STR$
    (TP):X = 115:Y = 30: GOSUB 1
    00
272  GOSUB 99:BT = NG:LW = N1:LU
     = N2: GOSUB 99: ON NG GOTO
    273,274
273 BT = BT / TO:DS$ = Z$ +  STR$
    (BT):X = 115: GOTO 275
274 DS$ =  STR$ (BT):X = 143
275  DRAW T3 AT 98,50:Y = 50: GOSUB
    100
276 AN = TP * BT:AN$ =  STR$ (AN
    ): GOSUB 150: GOSUB 130: RETURN

300 CH%(46) = NO:K = NO:CH%(127)
     = NO:IN$ = "":ST = NO: POKE
    RS,NO:CC = N3
301 LN% = N5:K = K + N1: IF K >
    T2 THEN  HCOLOR= CC: DRAW T5
     AT X,Y:K = NO:CC = N3 - (CC
     = N3) * N3
```

```
302 KY% =  PEEK (KB): IF KY% < L
    M THEN 301
303  POKE RS,NO:KY% = KY% - LM: IF
    CH%(KY%) = NO THEN 301
304  ON CH%(KY%) GOTO 305,307,30
    1,311
305  IF LN% >  LEN (IN$) THEN C$
     =  CHR$ (KY%):IN$ = IN$ + C
    $:CH%(127) = N2: GOSUB 110
306  GOTO 301
307  IF  LEN (IN$) = N1 THEN IN$
     = "":CH%(127) = NO: GOTO 30
    9
308 IN$ =  LEFT$ (IN$, LEN (IN$)
     - N1)
309  HCOLOR= NO: DRAW T5 AT X,Y:
     DRAW IN(ST) AT XX(ST),YY(ST
    ):X = XX(ST):Y = YY(ST):ST =
    ST - N1:TM = TM + N8: IF IN(
    ST + N1) = T4 THEN Y = Y - N
    4:CH%(46) = N1
310  GOTO 301
311  IF IN$ = "" THEN 301
312  HCOLOR= NO: DRAW T5 AT X,Y
313  GOTO 25001
950  POKE RS,NO: VTAB 22: HTAB N
    6: PRINT "Press [SPACE BAR]
    to continue."
951 KY =  PEEK (KB): IF KY < LM THEN
    951
952  POKE RS,NO: IF KY <  > SB THEN
    951
953  VTAB 22: HTAB N3: PRINT W$(
    0): RETURN
16000  FOR T = 1 TO 127:CH%(T) =
    NO: NEXT :CH%(13) = N4
16001  FOR T = 48 TO 57:CH%(T) =
    N1: NEXT :LN% = N6:CH%(46) =
    N1
16002  RETURN
17000 NO = 0:N1 = 1:N2 = 2:N3 =
    3:N4 = 4:N5 = 5:N6 = 6:N7 =
    7:N8 = 8:N9 = 9:T0 = 10:T1 =
    11:T2 = 12:T3 = 13:T4 = 14:L
    M = 128:RS = 49168:KB = 4915
    2:W7 = 36
17001  FOR I = 0 TO 14: READ FD$
    (I): NEXT :MN = 0:DD = 1630:
    TM = 0:CT = 0:SB = 160:AC =
    0:AQ = 0:SC = 0:SQ = 0:MC =
    0:MQ = 0:HU = 100:T8 = 18:T6
     = 16:T5 = 15:T9 = 19:W1 = 2
    1:QT = .6
17002 W$(0) = "
                            ":DOT$ =
    ".":W$(1) = "
           ":SW = .0000001:Z$ = "
    0":AS = .002
17010  RETURN
```

```
18000 L =  PEEK (33000):NA$ = ""
     : FOR C = N1 TO L:NA$ = NA$ +
      CHR$ ( PEEK (33000 + C)): NEXT
     : RETURN
25000  PRINT  CHR$ (7): HOME : CALL
      - 3086: VTAB TO: PRINT "Ent
     er summary code:":X = 145:Y =
     68: GOTO 300
25001  IF IN$ <  > "0070" THEN 2
     5000
25100  HOME : CALL  - 3086: HTAB
     17: PRINT "Summary"
25102  VTAB N3: PRINT "ADDITION:
     ": PRINT
25104  PRINT "Number of question
     s tried:";: HTAB 29: PRINT A
     Q
25106  PRINT "Number of correct
     answers:";: HTAB 29: PRINT A
     C
25108  IF AQ > NO THEN  PRINT "P
     ercent correct:";: HTAB 29: PRINT
      INT ((AC / AQ) * 100 + .5);
     "%"
25110  VTAB TO: PRINT "SUBTRACTI
     ON": PRINT
25112  PRINT "Number of question
     s tried:";: HTAB 29: PRINT S
     Q
25114  PRINT "Number of correct
     answers:";: HTAB 29: PRINT S
     C
25116  IF SQ > NO THEN  PRINT "P
     ercent correct:";: HTAB 29: PRINT
      INT ((SC / SQ) * 100 + .5);
     "%"
25118  VTAB 17: PRINT "MULTIPLIC
     ATION": PRINT
25120  PRINT "Number of question
     s tried:";: HTAB 29: PRINT M
     Q
25122  PRINT "Number of correct
     answers:";: HTAB 29: PRINT M
     C
25124  IF MQ > NO THEN  PRINT "P
     ercent correct:";: HTAB 29: PRINT
      INT ((MC / MQ) * 100 + .5);
     "%"
25126  VTAB 24: HTAB N3: PRINT "
     Press [CONTROL-RESET] to sta
     rt over."
25128  GOTO 25126
26000  CALL  - 1370
30000  DATA  "Yes, that is corre
     ct,"
30001  DATA  "Good thinking,"
30002  DATA  "Keep up the good w
     ork,"
```

```
 30003  DATA  "Nice going,"
 30004  DATA  "That is correct,"
 30005  DATA  "Correct,"
 30006  DATA  "Nice work,"
 30007  DATA  "Good choice,"
 30008  DATA  "You're right,"
 30009  DATA  "That's right,"
 30010  DATA  "No, that is incorr
     ect,"
 30011  DATA  "Wrong choice,"
 30012  DATA  "Sorry,"
 30013  DATA  "Incorrect,"
 30014  DATA  "You are incorrect,
     "
]LOAD RMM
]LIST

 5  HIMEM: 31000
 10  POKE 1012,0
 20  ONERR  GOTO 1000
 50  POKE  - 16304,0: POKE  - 163
     02,0: POKE  - 16300,0: POKE
      - 16297,0: POKE 230,32: CALL
      - 3086
 100  FOR I = 0 TO 87: READ X: POKE
     768 + I,X: NEXT
 102  PRINT  CHR$ (4)"BLOAD FONT.
     MATH,A31000": POKE 6,24: POKE
     7,121
 104  POKE 54,0: POKE 55,3: CALL
     1002
 106  PRINT  CHR$ (4)"BLOAD NUMBE
     RS, A32000"
 108  POKE 232,32000 -  INT (3200
     0 / 256) * 256: POKE 233, INT
     (32000 / 256)
 150  PRINT  CHR$ (4)"RUN MM"
 200  DATA  216,120,133,69,134,70
     ,132,71
 202  DATA  166,7,10,10,176,4,16,
     62
 204  DATA  48,4,16,1,232,232,10,
     134
 206  DATA  27,24,101,6,133,26,14
     4,2
 208  DATA  230,27,165,40,133,8,1
     65,41
 210  DATA  41,3,5,230,133,9,162,
     8
 220  DATA  160,0,177,26,36,50,48
     ,2
 222  DATA  73,127,164,36,145,8,2
     30,26
 224  DATA  208,2,230,27,165,9,24
     ,105
 226  DATA  4,133,9,202,208,226,1
     65,69
 228  DATA  166,70,164,71,88,76,2
     40,253
 1000  CALL  - 1370
```

APPENDIX C: EXAMPLES OF COMPUTER GENERATED QUESTIONS AND FEEDBACK STATEMENTS

$$\begin{array}{r} 0.9 \\ +\,0.45 \\ \hline 1.35 \end{array}$$

Good thinking, Keith

[SPACE BAR] gets the next question.

$$\begin{array}{r} 0.7 \\ -\,0.66 \\ \hline 0.04 \end{array}$$

Yes, that is correct, Keith

[SPACE BAR] gets the next question.

$$\begin{array}{r} 0.2 \\ \times\,0.9 \\ \hline 0.18 \end{array}$$

Good choice, Keith

[SPACE BAR] gets the next question.

```
  0.7
+ 0.15
------
  34
```

Sorry, Keith
The correct answer is .85
[SPACE BAR] gets the next question.

```
  0.9
- 0.32
------
  0.62
```

You are incorrect, Keith
The correct answer is .58
[SPACE BAR] gets the next question.

```
  0.1
x 0.3
------
  3
```

No, that is incorrect, Keith
The correct answer is .03
[SPACE BAR] gets the next question.

$$\begin{array}{r} 0.7 \\ -\,0.66 \\ \hline 0.16 \end{array}$$

Wrong choice, Keith

The correct answer is .04

[SPACE BAR] gets the next question.

$$\begin{array}{r} 0.7 \\ \times\quad 4 \\ \hline 2.8 \end{array}$$

Keep up the good work, Keith

[SPACE BAR] gets the next question.

Summary

Number of questions tried:	31
Number of correct answers:	16
Percent correct:	52%

APPENDIX D: DECIMALS PRE-TEST

DECIMALS PRE-TEST NAME: ____________________

Write your answers in the space provided. Scrap paper is available for your work. This is a timed test so you will not finish all questions.

0.6 + 0.82	0.8 - 0.69	0.5 x 0.3	0.6 + 0.93	0.6 - 0.49	0.3 x 0.4
0.5 + 0.45	0.6 - 0.06	0.1 x 9	0.9 + 0.15	0.9 - 0.5	0.2 x 1
0.7 + 0.3	0.6 - 0.26	0.7 x 0.6	0.4 x 0.46	0.8 -0.02	0.3 x 7
0.9 + 0.68	0.5 - 0.01	0.7 x 4	0.6 + 0.78	0.7 - 0.44	0.1 x 4
0.9 + 0.54	0.2 - 0.17	0.6 x 1	0.6 + 0.33	0.3 - 0.29	0.5 x 1
0.6 + 0.13	0.3 - 0.02	0.7 x 7	0.9 + 0.93	0.3 - 0.1	0.4 x 1

PRE-TEST

0.9 + 0.14	0.8 - 0.15	0.1 x 0.1	0.6 + 0.21	0.3 - 0.12	0.2 x 0.9
0.9 + 0.73	0.9 - 0.88	0.1 x 6	0.3 + 0.5	0.9 - 0.86	0.6 x 4
0.8 + 0.72	0.8 - 0.55				

APPENDIX E: DECIMALS POST-TEST

DECIMALS POST-TEST NAME: ____________________

Write your answers in the space provided. Scrap paper is available for your work. This is a timed test so you will not finish all questions.

0.1 + 0.85	0.6 -0.44	0.2 x 0.9	0.8 + 0.37	0.8 - 0.22	0.9 x 0.7
0.3 + 0.08	0.8 - 0.41	0.5 x 0.7	0.3 + 0.64	0.6 - 0.59	0.4 x 0.2
0.2 + 0.37	0.5 - 0.14	0.5 x 0.2	0.2 + 0.79	0.3 - 0.18	0.6 x 0.4
0.7 +0.69	0.7 - 0.44	0.6 x 1	0.5 + 0.18	0.4 - 0.15	0.6 x 0.5
0.3 +0.83	0.2 - 0.09	0.5 x 0.2	0.2 + 0.46	0.9 - 0.73	0.7 x 0.4
0.2 +0.27	0.2 - 0.11	0.5 x .9	0.2 + 0.13	0.6 -0.02	0.8 x0.5

0.4	0.3	0.3	0.4	0.5	0.7
+ 0.33	- 0.1	x 8	+ 0.78	- 0.15	x 1
0.3	0.4	0.9	0.8	0.3	0.3
+ 0.5	- 0.13	x 0.6	+ 0.68	- 0.1	x 0.5
0.7	0.2				
+ 0.73	- 0.1				

APPENDIX F: IAR SCALE

THE IAR SCALE

INSTRUCTIONS: Each question below has two possible endings. Pick the one that best describes what happens to you or how you feel. There are no right or wrong answers.

1. If a teacher passes you to the next grade, would it probably be

____a. because she liked you, or
____b. because of the work you did?

2. When you do well on a test at school, is it more likely to be

____a. because you studied for it, or
____b. because the test was especially easy?

3. When you have trouble understanding something in school is it usually

____a. because the teacher didn't explain it clearly, or
____b. because you didn't listen carefully?

4. When you read a story and can't remember much of it, is it usually

____a. because the story wasn't well written, or
____b. because you weren't interested in the story?

5. Suppose your parents say you are doing well in school. Is this likely to happen

____a. because your school work is good, or
____b. because they are in a good mood?

6. Suppose you did better than usual in a subject at school. Would it probably happen

____a. because you tried harder, or
____b. because someone helped you?

7. When you lose at a game of cards or checkers, does it usually happen

____a. because the other player is good at the game, or
____b. because you don't play well?

8. Suppose a person doesn't think you are very bright or clever.

____a. can you make him change his mind if you try to, or
____b. are there some people who will think you're not very bright no matter what you do?

9. If you solve a puzzle quickly, is it

____a. because it wasn't a very hard puzzle, or
____b. because you worked on it carefully?

THE IAR SCALE - cont'd

10. If a boy or girl tells you that you are dumb, is it more likely that they say that

_____a. because they are mad at you, or
_____b. because what you did really wasn't very bright?

11. Suppose you study to become a teacher, scientist, or doctor and you fail. Do you think this would happen

_____a. because you didn't work hard enough, or
_____b. because you needed some help, and other people didn't give it to you?

12. When you learn something quickly in school, is it usually

_____a. because you paid close attention, or
_____b. because the teacher explained it clearly?

13. If a teacher says to you, "Your work is fine," is it

_____a. something teachers usually say to encourage pupils, or
_____b. because you did a good job?

14. When you find it hard to work arithmetic or math problems at school, is it

_____a. because you didn't study well enough before you tried them, or
_____b. because the teacher gave problems that were too hard?

15. When you forget something you heard in class, is it

_____a. because the teacher didn't explain it very well, or
_____b. because you didn't try very hard to remember?

16. Suppose you weren't sure about the answer to a question yor teacher asked you, but your answer turned out to be right. Is it likely to happen

_____a. because she wasn't as particular as usual, or
_____b. because you gave the best answer you could think of?

17. When you read a story and remember most of it, is it usually

_____a. because you were interested in the story, or
_____b. because the story was well written?

18. If your parents tell you you're acting silly and not thinking clearl is it more likely to be

_____a. because of something you did, or
_____b. because they happen to be feeling cranky?

19. When you don't do well on a test at school, is it

_____a. because the test was especially hard, or
_____b. because you didn't study for it?

THE IAR SCALE - cont'd

20. When you win at a game of cards or checkers, does it happen

_____a. because you play real well, or
_____b. because the other person doesn't play well?

21. If people think you're bright or clever, is it

_____a. because they happen to like you, or
_____b. because you usually act that way?

22. If a teacher didn't pass you to the next grade, would it probably be

_____a. because she "had it in for you," or
_____b. because your school work wasn't good enough?

23. Suppose you don't do as well as usual in a subject at school. Would this probably happen

_____a. because you weren't as careful as usual, or
_____b. because somebody bothered you and kept you from working?

24. If a boy or girl tells you that you are bright, is it usually

_____a. because you thought up a good idea, or
_____b. because they like you?

25. Suppose you became a famous teacher, scientist or doctor. Do you think this would happen

_____a. because other people helped you when you needed it, or
_____b. because you worked very hard?

26. Suppose your parents say you aren't doing well in your school work. Is this likely to happen more

_____a. because your work isn't very good, or
_____b. because they are feeling cranky?

27. Suppose you are showing a friend how to play a game and he has trouble with it. Would that happen

_____a. because he wasn't able to understand how to play, or
_____b. because you couldn't explain it well?

28. When you find it easy to work arithmetic or math problems at school, is it usually

_____a. because the teacher gave you especially easy problems, or
_____b. because you studied your book well before you tried them.

29. When you remember something you heard in class, is it usually

_____a. because you tried hard to remember, or
_____b. because the teacher explained it well?

THE IAR SCALE - cont'd

30. If you can't work a puzzle, is it more likely to happen

_____a. because you are not especially good at working puzzles, or
_____b. because the instructions weren't written clearly enough?

31. If your parents tell you that you are bright or clever, is it more likely

_____a. because they are feeling good, or
_____b. because of something you did?

32. Suppose you are explaining how to play a game to a friend and he learns quickly. Would that happen more often

_____a. because you explained it well, or
_____b. because he was able to understand it?

33. Suppose you're not sure about the answer to a question your teacher asks you and the answer you give turns out to be wrong. Is it likely to happen

_____a. because she was more particular than usual, or
_____b. because you answered too quickly?

34. If a teacher says to you, "Try to do better," would it be

_____a. because this is something she might say to get pupils to try harder, or
_____b. because your work wasn't as good as usual?

APPENDIX G: CAUSAL ATTRIBUTION FORMAT

COMPUTERIZED DECIMALS

NAME: ____________________

1. How well do you think you are going to do on your next computer session on decimals (give a percentage)?

2. How certain do you feel that the percentage you said you will get will actually be your mark (place an "X" on the scale below)?

Not certain at all			somewhat certain				certain			very certain
0	1	2	3	4	5	6	7	8	9	10

3. What do you think is the main reason (or cause) for your marks up to this point?

____

4. Causal Dimension Scale

Instructions: Think about the reason you gave in question 3. The items below concern your impressions or opinions of this cause of your outcome. Circle one number for each of the following scales.

1.	Is the cause(s) something that: Reflects an aspect of yourself	9	8	7	6	5	4	3	2	1	Reflects an aspect of the situation
2.	Is the cause(s): Controllable by you or other people	9	8	7	6	5	4	3	2	1	Uncontrollable by you or other people
3.	Is the cause(s) something that is: Permanent	9	8	7	6	5	4	3	2	1	Temporary
4.	Is the cause(s) something: Intended by you or other people	9	8	7	6	5	4	3	2	1	Unintended by you or other people
5.	Is the cause(s) something that is: Outside of you	1	2	3	4	5	6	7	8	9	Inside of you
6.	Is the cause(s) something that is: Variable over time	1	2	3	4	5	6	7	8	9	Stable over time
7.	Is the cause(s): Something about you	9	8	7	6	5	4	3	2	1	Something about others
8.	Is the cause(s) something that is: Changeable	1	2	3	4	5	6	7	8	9	Unchanging
9.	Is the cause(s) something for which: No one is responsible	1	2	3	4	5	6	7	8	9	Someone is responsible