

AN ABSTRACT OF THE THESIS OF

Catherine K. Whyte for the degree of Doctor of Philosophy in

Education presented on July 28, 1986.

Title: The Effects of Locus of Control and Instructional Method on Self-efficacy with Computers

Redacted for Privacy

Abstract approved: _____
Richard C. Forcier

The purpose of this experiment was to investigate the interactive effects of locus of control and instructional method on perceived self-efficacy with computers. The two instructional methods in this experiment were intended to represent variations in the amount of control over the lesson that students would have, the amount of self-directed performance opportunities that would be provided in the activity, and to contrast inductive and deductive teaching methods using the computer. The treatments were identified by the names "student-controlled" and "program-controlled". The two instructional methods were designed to be congruent with two generalized locus of control orientations, "internal" and "external".

The general hypothesis was that subjects who receive instruction using computers by a method that is more congruent with their locus of control orientation would have greater perceptions of self-efficacy about using computers than subjects who experience instruction by methods that are incongruent with their locus of control orientation.

A total of 95 preservice teachers (both elementary and secondary) participated in the experiment. A two-by-two factorial design was used, in which subjects were blocked by locus of control orientation (internal/external) and then randomly assigned to the two instructional methods (student-

controlled/program-controlled) yielding four treatment groups. A measure of perceived self-efficacy was obtained from the entire sample following the instructional period. These data were analyzed using appropriate analysis of variance and multivariate analysis of variance procedures.

The results of the test of perceived self-efficacy were not conclusive. Although there were no statistically significant main effects or interaction effects for locus of control and instructional method, examination of the means for each group indicated that the results tended in the expected direction. Internal subjects who received the student-controlled treatment had higher mean scores than internals in the program-controlled group. External subjects receiving the program-controlled treatment had higher mean scores than externals in the student-controlled group.

THE EFFECTS OF LOCUS OF CONTROL AND INSTRUCTIONAL METHOD
ON SELF-EFFICACY WITH COMPUTERS

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed July 28, 1986

Commencement June 1987

APPROVED:

Redacted for Privacy

Professor of Education in charge of major

Redacted for Privacy

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Date thesis is presented

July 28, 1986

ACKNOWLEDGEMENTS

I would like to extend a very sincere thank-you to all the members of my committee. First, to my major professor, Dr. Richard Forcier, whose support and encouragement over the past 5 years made this happen. Next, to Dr. Bert Kersh, for his guidance and editorial support, Dr. Billie Hughes for forcing me to do my best, Dr. Jean Ferguson for lending me a shoulder to cry on, and Dr. David Andrews for helping me understand how statistics work.

My biggest thanks go to Merryellen and Donald G.. They made me know I could do it, and deserve little letters behind their names as much as I do.

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THE EFFECTS OF LOCUS OF CONTROL AND INSTRUCTIONAL METHODS ON SELF-EFFICACY WITH COMPUTERS

CHAPTER 1

INTRODUCTION

Statement of the Problem

The central purpose of this study is to investigate the interaction of personality characteristics and differing activities in enhancing an individual's perception of his/her ability to perform in a specific situation. An experiment was conducted to test whether a person's generalized locus of control orientation interacts in predictable ways with different instructional methods in activities designed to enhance perceived self-efficacy with computers. The feeling that one is competent to perform masterfully in a particular situation (perceived self-efficacy) may affect that individual's motivation to become involved with those situations. A clearer understanding of the interaction of generalized locus of control with instructional methods in enhancing perceived self-efficacy will aid in the development of instructional activities designed to motivate students to use and learn about computers.

Perceived Self-efficacy

According to the self-efficacy theory of behavioral change, as posited by Albert Bandura (1977a), a person's perceived self-efficacy (or self-perception of ability to cope and deal with a given situation) affects that person's choice of activities. People avoid activities that they perceive to be beyond their coping capabilities, but undertake and perform assuredly those that they feel capable of managing.

The most dependable source of information on which people base personal efficacy expectations is performance accomplishment or personal experience. Four factors which may influence the

likelihood that performance successes will raise perceived efficacy are (1) the difficulty of the task, (2) the amount of external aid they receive, (3) the situational circumstances under which the performance occurs, and (4) the amount and variety of self-directed performance opportunities they have (Bandura, 1977a, p. 200-202; 1977b, p. 83; 1981, p. 205). Such factors should be considered when designing experiences to change efficacy expectations. Self-efficacy theory is discussed more fully in Chapter 2.

Locus of Control

The effectiveness of any treatment in positively enhancing perceived self-efficacy may also depend on intervening personality variables of the individuals. Locus of control is one variable that may interact with instructional method in activities designed to raise perceptions of self-efficacy.

Locus of control, as conceived by Rotter (1966), is a generalized expectancy for internal or external control of reinforcements. It may be seen as a generalized orientation to the causal nature of events in one's life, and therefore may affect how one will react in specific situations.

An individual's locus of control orientation is determined by the degree to which it is perceived that (a) events follow from or are contingent on specific behaviors or attributes, or (b) are a result of outside conditions, independent of any actions. Persons with an *internal* locus of control (internals) are those who see events, both positive and negative, as the consequences of their own behavior and thereby under personal control. Those persons classified as *externals*, on the other hand, are those who see positive and negative events as unrelated to their own behavior, or as being beyond their personal control.

Parent, Canter & Mohling (1975), Horak & Slobodzian (1980), and Horak and Horak (1982) have found that there is an interaction between the generalized expectancy of locus of control and instructional methods in the area of academic achievement. Internal subjects achieve more in student-controlled, low-structured, low-disciplined settings, and ones in which an inductive teaching method is used. Externally-controlled students make greater achievement gains in teacher-controlled environments, with high-structure and high-discipline, and when deductive teaching methods are employed. The results of these studies have shown that when instructional methods are congruent

with an individual's locus of control, greater achievement gains are the result (see Chapter 2 for a more detailed discussion of this research). Although these studies show that there is an interaction of locus of control and instructional methods which affects achievement, the evidence for the interaction of locus of control and instructional methods in affecting perceived self-efficacy is not clear.

Importance of the Study

The issue of whether or not instructional methods interact with locus of control in affecting perceptions of self-efficacy may be especially important when training for the use of new technologies. Technological developments are increasing at an ever rapid pace, and many people may feel threatened and intimidated when faced with the necessity to learn how to effectively use new technologies. Designing instructional activities that will promote the highest level of perceived self-efficacy for their use in all people may help to insure that the potential of these technologies will be maximized.

One new technology that is becoming more and more a part of the instructional programs in schools throughout the country is microcomputers. A recent Market Data Retrieval survey indicates that the number of microcomputers in schools nearly doubled in the last 2 years (The leading edge, 1985). The survey findings show that 94.2 percent of all districts now use computers for instruction - up from 86.1 percent last year.

Although there is a considerable body of research which shows that computer-based instruction enhances student learning, some researchers (Clark, 1983, 1985a, 1985b, Clark & Salomon, 1986) suggest that teacher differences in the implementation of computers may account for differential learning of students more than the medium of the computer itself. This view is expressed by David Moursund (1983a), editor of *The Computing Teacher*. He writes:

The essence of the current movement for computers in education is not the hardware and software. It is the people, with their knowledge, skills and involvement (p. 4).

These researchers would agree, then, that it is important for teachers to be knowledgeable about computers and about the effective implementation of computers in education.

While the numbers of computers in schools have increased dramatically, Moursund (1986) feels that teachers' training has not kept pace with this current development. Wesley, Krockover & Hicks (1985) point to the lack of knowledge among educators as one of the most critical barriers to the effective and widespread use of microcomputers. Dickerson and Pritchard (1981) contend that:

[C]omputer illiterate student educators graduating from higher education represent a major problem contributing to the literacy crisis (p. 7).

The problem is two-fold: (1) how to adequately prepare preservice teachers for the use of computers in their future classrooms; (2) and, the retraining of teachers already in the field through inservice programs. Carey (1985/1986) has shown that the number of hours of computer training spent in university courses is significantly related to the extent of computer use by teachers in their classrooms. These findings suggest that for teachers to be adequately prepared to maximize the potential of computers in their future instructional programs, they should be encouraged to complete coursework which will provide them with the opportunity for an in depth study of computers in education. Moursund (1983b) proposed that every teacher should have the opportunity to take the equivalent of two full courses (four-credit quarter length courses or three-credit semester length courses) in the area of computer education.

Unfortunately, many preservice teacher programs lack the time and space to require such additional coursework (Sherwood, Connor & Golberg, 1981, Lorber, 1984), and most inservice programs do not achieve the depth and breadth necessary for adequate training (Moursund, 1983b). The problem, then, becomes one of motivating both pre-service and inservice teachers to complete additional study on an elective basis.

Most preservice and inservice teachers realize that computers are increasingly being used in schools across the country. Although many may understand the importance of incorporating computers into their curriculum, not all believe that they are capable of using a computer themselves (Lorber, 1984). Beall and Harty (1984) have found that teachers' perception of competence using computers is highly significant in influencing whether or not they will implement computers in their classrooms. Some teachers may even suffer from "computerphobia", or intense anxiety about

computers, which could be a factor inhibiting them from obtaining necessary computer skills. The initial introduction teachers have to computers, whether in inservice or preservice programs, could be critical in affecting their perceptions of competence in dealing with computers, and thereby influencing their decision to enroll in further courses. Specifically, the introductory experience needs to be such that they build confidence, or perceived self-efficacy, in their ability to use the computer.

Overview of the Study

The experiment that was conducted as part of this study was designed to examine the interactive effects of two different instructional methods and locus of control on preservice teachers' perceived sense of efficacy with computers. The subjects chosen for the experiment were enrolled in three different required courses for elementary and secondary education majors at Western Oregon State College. Based on their scores on the Rotter Internal/External Control Scale (Rotter, 1966), subjects were classified as internals or externals and then randomly assigned to two treatment groups.

In the experiment, subjects in both treatment groups used a computer to complete self-instructional lessons introducing them to the Logo computer programming language. Two of the four variables identified by Bandura (1977a, p. 200-202; 1977b, p. 83; 1981, p. 205) that contribute to the effectiveness of efficacy-enhancing experiences (difficulty and situational circumstances) were controlled. What varied in the two treatments were the amount of self-directed performance opportunities provided in the lesson and the level of student control over the instruction. Use of the computer was a common feature embedded within each activity. One treatment (called "program-controlled") consisted of a self-instructional module which provided for relatively minimal control of the lesson by the user and no opportunity for self-directed performance. Subjects in the second treatment group (called "student-controlled") utilized a self-instructional module which provided them with a relatively high degree of control over what they experienced with the computer and what they saw on the screen. After treatments were completed, perceived self-efficacy was measured using the

affective portion of the *Minnesota Computer Literacy and Awareness Assessment* (Anderson, Hansen, Johnson, & Klassen, 1979a).

Research Questions

The central questions of the present study are:

1. Is there an interaction effect between locus of control and instructional method on perceptions of self-efficacy?
2. If so, which instructional method will promote the greatest perception of self-efficacy for internally and externally controlled subjects?

Locus of control has been shown to interact with instructional method in achievement situations. In the experiment it was hypothesized that there is an interaction between locus of control and instructional method on perception of self-efficacy, as follows: When the instructional method is congruent with the individual's locus of control, a greater perception of self-efficacy is the result. It also was hypothesized that internally controlled subjects have a greater perception of self-efficacy after instruction with the student-controlled computer module and that externally controlled subjects have a greater perception of self-efficacy after instruction with the program-controlled module.

Definition of Terms

Locus of Control : A generalized expectancy for internal or external control of reinforcements. "Internal control" refers to an individual's belief that an event or outcome is contingent on his or her own behavior or on relatively permanent characteristics such as ability. The belief that an event is caused by factors beyond the individual's control (e.g., luck, task difficulty, powerful other) has been labeled "external control" (Stipek & Weisz, 1981, p. 103).

Perceived Self-efficacy: Self-judgements of how well one can execute courses of action required to deal with specific situations (Bandura, 1982, p. 122).

The present study examines the relationship between the generalized personality characteristic of locus of control, as outlined by Rotter (1966), and perceptions of self-efficacy in a specific situation, as conceived by Bandura (1977a, 1977b, 1981, 1982, 1984). Is it important that instructional activities are congruent with generalized locus of control orientation when the goal is to enhance self-efficacy in a particular situation?

Limitations of the Study

This study addresses the question of interaction between locus of control and instructional methods in enhancing perceptions of self-efficacy by examining the specific case of teachers' attitudes towards computers. Further study is needed to generalize these findings to other instructional tasks.

Although the problem of adequate training in the use of computers for teachers exists at both the preservice and inservice levels, the present study focused solely on experiences provided for preservice teachers. Subjects for this study were all enrolled in three intact required classes for elementary and secondary teacher education majors at Western Oregon State College. The generalizability of these findings to the population of pre-service teachers is limited because the sample may not be representative of preservice teachers at Western Oregon State College or elsewhere. The sample is described more fully in Chapter 3.

Subjects in this study were classified as having an internal or external locus of control based on their scores on the *Rotter Internal/External Control Scale* (Rotter, 1966). Because of the somewhat small sample size in this study, the midpoint of the range of scores was used as the dividing point for this classification. In other studies on locus of control (e.g. Parent, Forward, Canter, & Mohling, 1975; Brice & Sassenrath, 1978), analysis of data was performed using only the upper- and lower-third scores for locus of control. The latter method provides for a clearer distinction between internal and external subjects, and the results of this present study may be limited by the inclusion of data from subjects falling in the middle third of the internal/external continuum.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

Introduction

As previously stated in Chapter 1, this study involved an experiment which investigated the interaction of locus of control and instructional methods in activities designed to enhance perceived self-efficacy with computers. The theoretical basis for this present study comes from two sources: Bandura's (1977a, 1977b, 1981, 1982, 1984) self-efficacy theory and Rotter's (1966) internal/external locus of control theory.

The review of the literature related to this study is divided into five main sections: (1) self-efficacy theory; (2) locus of control theory; (3) the relationship of locus of control to self-efficacy; (4) the interaction of locus of control and instructional methods, and; (5) research in computer education studying self-efficacy, locus of control, and instructional methods.

Because overall attitudes towards using computers in the classroom may involve perceived self-efficacy, the first section discusses the theory base of perceived self-efficacy and related research. First a definition and description of the perceived self-efficacy construct as outlined by Bandura is offered. Then, sources of perceived self-efficacy are reviewed, and factors related to the effectiveness of experiences designed to enhance perceptions of self-efficacy are discussed.

The second section includes a review of the literature on locus of control: a definition and discussion of this construct; and discussion of research related to locus of control and achievement.

Next, a discussion of the relationship of the locus of control theory to self-efficacy theory is offered. Weiner's attribution theory is offered in contrast.

The interaction of locus of control and instructional methods is discussed in the fourth section of the chapter. Research showing the relationship between instructional method and locus of control

in achievement situations is reviewed. Support for the hypothesis that congruence between locus of control and instructional methods leads to greater perceptions of self-efficacy is offered.

Specific studies that have investigated perceived self-efficacy and/or locus of control in computer education occupy the final section. A rationale for the present study, based on this previous research is presented.

Perceived Self-Efficacy

Perceived self-efficacy, as first introduced by Albert Bandura (1977a), is an integrative theoretical framework that explains and predicts psychological changes that can occur as a result of experience. While most of the early research studying perceived self-efficacy focused on fearful and avoidant behavior, more recent studies have investigated the validity of this theory in relation to areas such as achievement behavior (Schunk, 1981-1984; Lent, Brown, & Larkin, 1984), weight control (Weinberg, 1984; Bernier & Poser, 1984; Mitchell & Stuart, 1984), smoking cessation (Brod & Hall, 1984; Coelho, 1984; Shiffman, 1984; Nicki, Remington, & MacDonald, 1984), alcoholism (Miller, 1983), and assertiveness (Lee, 1984a & b). The results of these studies have clearly shown that the self-efficacy theory applies to non-phobic, as well as phobic populations.

Bandura (1977b, p. 79) differentiates between two types of expectations that persons have when faced with performance situations. "Outcome expectancies" are those that have to do with the persons' beliefs that given behaviors will lead to certain outcomes. "Efficacy expectancies" deal with whether or not people believe that they are capable of performing the actions necessary to produce the desired outcomes. The distinction between these two types of expectations is important in that individuals may be aware of the benefits of using computers in educational settings (high outcome expectancies), but at the same time, not feel that they are capable of actually using a computer themselves (low perceived self-efficacy).

According to Bandura's theory, perceived self-efficacy is a major determinant of people's choice of activities, how much effort they will expend in the activity, and how long they will sustain effort if the situation is stressful.

People fear and tend to avoid threatening situations they believe exceed their coping skills, whereas they get involved in activities and behave assuredly when they judge themselves capable of handling situations that would otherwise be intimidating.

Not only can perceived self-efficacy have directive influence on choice of activities and settings, but, through expectations of eventual success, it can affect coping efforts once they are initiated. Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences. (Bandura, 1977a, p. 194)

If preservice teachers have low perceptions of self-efficacy with computers, the low sense of self-efficacy may contribute to an unwillingness to engage in computer education activities, and may affect the teacher's persistence in efforts to master necessary computer skills.

Bandura has stated that perceived self-efficacy operates as "one common mechanism through which diverse influences affect human action, thought, and affective arousal" (Bandura, 1984, p 231). Bandura (1977a, 1977b, 1981, 1982, 1984) outlines several sources of information on which people base personal efficacy expectations: verbal persuasion, vicarious experience, emotional arousal and performance accomplishment. Attempts to modify self-efficacy expectations may use any or all of these sources. *Verbal persuasion* is probably the most widely used because of its ease and ready availability. Through suggestions and exhortations, the individuals are led to believe that they can successfully cope with the particular situation. Bandura points out that efficacy expectations achieved through the verbal persuasion method are relatively short-lived and weak, as there is no experiential basis for them (Bandura, 1977b, p. 82).

A second source of efficacy information is *vicarious experience*. Here, individuals see others perform the desired activities, either in live modeling or symbolic modeling situations. When the models are able to perform successfully without suffering adverse effects, the subjects are thus led to believe that they too will be able to succeed in performing the action. The number and characteristics of the models are variables which can modify the effectiveness of this technique (Bandura, 1977b, p. 81-82).

Perceptions of self-efficacy may also be determined by the level of *emotional arousal* persons feel in a particular situation. Because stressful situations generally elicit high levels of emotional arousal, which in turn debilitate performance, individuals are more likely to expect more effective functioning when they are not tense and viscerally agitated (Bandura, 1977b, p. 82).

Researchers have consistently shown that the most dependable source of efficacy expectations is *performance accomplishment* (Bandura & Adams, 1977; Bandura, Adams & Beyer, 1977; Bandura, Adams, Hardy, & Howells, 1980). In these studies, therapy based on participant modeling was contrasted with treatments using vicarious experiences, cognitive scenarios and emotive-oriented procedures.

In the treatment using enactive mastery, subjects were initially assisted with performance induction aids, including such things as preliminary modeling of activities, graduated tasks, joint performance with the therapist, and protective aids to reduce the likelihood of feared consequences. These induction aids were gradually withdrawn as the subjects' ability to cope with the situation increased. After this phase of the therapy, subjects were provided with the opportunity for self-directed mastery experiences to reinforce their sense of self-efficacy.

The vicarious, cognitive and emotive oriented modes of treatment, which were contrasted with the participant modeling method, involved no physically active participation by the subjects. In the vicarious treatment, subjects observed strategies being modeled but did not execute any actions themselves. The cognitively based therapy relied on subjects generating cognitive scenarios in which different models successfully performed desired activities. The emotive-oriented procedure used a desensitization treatment where people visualized threatening scenes while deeply relaxed until anxiety arousal was dissipated (Bandura, 1977a, p. 196-197; 1982, p. 127).

Results of these studies confirmed that all of these modes of treatment can raise self-perceptions of efficacy, but that enactive mastery experiences produce the highest, strongest, and most generalized increases in efficacy (Bandura, 1982, p. 127-128). Other comparative studies (Biran & Wilson, 1981; Feltz, Landers, & Raeder, 1979; Katz, Stout, Taylor, Horne, & Agras, 1981; Leone, Minor, & Baltimore, 1983) have corroborated these results.

Enactive attainments provide the most influential source of efficacy information because they are based on authentic mastery experiences (Bandura, 1982, p. 126).

Based on the individual's own personal experiences, success or failure will raise or lower mastery expectations respectively. And once established in this manner, the efficacy expectations tend to generalize to related situations (Bandura, Adams & Beyer, 1977; Bandura, Jeffrey, & Gajdos, 1975). In order to increase individuals' sense of self-efficacy with computers, then, it would be best to design activities that will provide for successful performance accomplishments using a computer.

When designing enactive experiences to change efficacy expectations, many factors must be taken into consideration. Bandura states:

Judgement of self-efficacy from enactive information is an inferential process in which the relative contribution of personal and situational factors must be weighted and integrated (Bandura, 1982, p. 124).

Five factors that determine the effectiveness of efficacy-enhancing experiences are (1) the subject's perception of the difficulty of the task, (2) the amount of external aid received, (3) the situational circumstances under which performance takes place, (4) the amount of effort expended, and (5) the temporal pattern of successes and failures. Bandura states:

Mastery of an easy task is redundant with what one already knows, whereas mastery of a difficult task conveys new efficacy information for raising one's efficacy appraisal. Successes achieved with external aid carry less efficacy value because they are likely to be credited to external factors rather than to personal capabilities. Similarly, faulty performances under adverse situational conditions will have much weaker efficacy implications than those executed under optimal circumstances.

Cognitive appraisals of effort expenditure may further affect the impact of performance accomplishments on judgements of personal efficacy. Success with minimal effort fosters ability ascriptions but analogous attainments gained through heavy labor connote a lesser ability and are thus likely to have weaker impact on perceived self-efficacy. The rate and pattern of attainments furnish additional information for judging personal efficacy. Individuals who experience periodic failures but continue to improve over time are more apt to raise their perceived efficacy than those who succeed but see their performances leveling off compared to their prior rate of improvement (Bandura, 1981, p. 205).

Bandura suggests that when attempting to change efficacy expectations, the optimal therapy is one where the environment is structured so that the subjects can perform successfully with a minimum amount of effort. Tasks should be ordered according to level of difficulty with supplementary aids

gradually being withdrawn, and opportunities for self-directed mastery experiences provided to reinforce a sense of personal efficacy (Bandura, 1977b, p. 84).

While Bandura notes that premature performance demands can undermine perceptions of self-efficacy, he also states that the generality and durability of therapeutic changes are a function of the amount and variety of self-directed performance (Bandura, 1977b). It is when individuals have the opportunity to perform successfully with minimal outside help that they experience authentic mastery and ability to cope with the performance demands. The amount, timing and variety of self-directed performance opportunities provided for in introductory computer experiences may contribute to the effectiveness of those experiences in enhancing perceptions of self-efficacy with computers.

Locus of Control

It has been suggested that responses to different instructional methods may be influenced by the personality, as well as ability, of individual learners (Cronbach & Snow, 1977). For example, the effectiveness of instructional methods designed to enhance perceived self-efficacy in using computers may depend on the intervening personality variable of locus of control (LOC). First posited by Julian Rotter in the late 1960s (Rotter, 1966), the locus of control construct grew out of clinical analysis when it was realized that some people seem to change their behavior as a result of experiences, whereas others discount new experiences by attributing them to chance or to others, not to their own behavior. An individual's locus of control orientation is determined by the degree to which it is perceived that rewards and punishments follow from or are contingent on specific behaviors or attributes, or are a result of outside conditions, independent of any actions. This generalized orientation may be seen as analogous to Bandura's concept of outcome expectancies (belief that given behaviors will lead to certain outcomes) in a specific situation.

Persons with an *internal* locus of control ("internals") are those who see events, both positive and negative, as the consequences of their own behavior, and thereby as being under personal control. The internal believes that rewards and reinforcements are a result of effort and ability and therefore feels

responsible for successes or failures. Those persons classified as *external* ("externals"), on the other hand, are those who see positive and negative events as unrelated to their own behavior, or as being beyond their personal control. Rewards and reinforcements are viewed by the external as dependent on luck, chance or significant others (Rotter, 1966, p. 25).

There has been considerable interest in the locus of control construct since it was first developed and much research on this construct has been conducted. Although data from studies examining the relationship between locus of control and achievement are inconsistent, there seems to be a trend showing that the more internal an individual's orientation is, the higher the individual's achievement will be (Bar-Tal & Bar-Zohr, 1977; Duke & Nowicki, 1974; Hill, 1978; Lefcourt, 1981-1984; Stake, 1979; Stipek & Weisz, 1981; Walden & Ramey, 1983).

The link between internality and higher achievement may be due to a number of attributes that internals tend to display. In reviews of the research on locus of control, Hill (1978) and Stipek and Weisz (1981) have identified the following characteristics of internals: they prefer and seek out skill situations, they are more apt to engage in information seeking and make better use of information in problem-solving, they are more sensitive to environmental cues and use better strategies of cognitive organization, and they tend to maximize self-direction and self-control. Hill concludes that these behaviors seem to be ones that contribute to higher achievement gains.

The Relationship of Locus of Control to Self-Efficacy

Rotter (1966) maintains that expectancies for internal versus external control of reinforcements generalize from a specific situation to a series of situations which are perceived as related or similar.

[Once established, this] generalized attitude, belief, or expectancy regarding the nature of the causal relationship between one's behavior and its consequences might affect a variety of behavioral choices in a broad band of life situations. (Rotter, 1966, p. 2)

In his review of the research on locus of control, Lefcourt (1981-1984) presents research findings by those who have questioned the value of a unidimensional scale of locus of control such as

Rotter's. A multidimensional conceptualization that differentiates between two types of externality is discussed. In the multidimensional model, one type of externality is that in which the person believes the world is random and unordered. The other external orientation involves the belief in the basic order and predictability of the world, but with powerful others in control.

Levenson (reported in Lefcourt, 1981) developed a measure to assess the multidimensional aspects of locus of control. Called the Internality, Powerful Others and Chance scales, these three subscales differentiate between three dimensions of locus of control. The "I" scale (Internal) measures the extent to which people believe they have control over their lives. The "P" scale (Powerful Others) deals with the degree to which people believe that powerful others control their life events. The "C" scale (Chance) is concerned with perceptions of chance as a controlling force in life.

Coovert and Goldstein (1980) used the I, P, and C scales in a study examining the relationship of locus of control to attitudes towards computers. They predicted that persons who have negative or unfavorable attitudes towards computers would view the computer as a powerful-other and thus would score high on Levenson's powerful-other dimension. The results of the Coovert and Goldstein experiment indicate that this is not the case. Although those subjects with negative attitudes did score slightly higher on both the powerful-other and chance scales than those with positive attitudes, the differences were not statistically significant. Thus, the results of the Coovert and Goldstein experiment suggest that the multidimensional model is no more helpful in identifying the relationship between locus of control and attitudes towards computers than the Rotter model.

Lefcourt (1981) also reports research on the development of other scales to measure locus of control. The attempt in the development of different scales is to extend the utility of the locus of control construct and to stimulate further research in making the construct more relevant to specific problems and concerns. Some scales discussed by Lefcourt include those designed for different aged samples, scales to explore realms of control such as interpersonal control and sociopolitical control, and goal-specific scales in areas such as alcoholism and mental health related behaviors.

Another model that can be contrasted to Rotter's generalized expectancy model for internal versus external of reinforcements is Weiner's attribution model (Weiner, 1972, 1974, 1977). The

Weiner model stresses situational determinants of perceptions of personal causality (as opposed to the generalized conception of Rotter) and may therefore be seen as more similar to Bandura's concept of self-efficacy.

In the attribution model, three dimensions of causality are identified: (1) locus of causality; (2) control; and (3) stability. Locus of causality (either internal or external) relates to the perception that outcomes are contingent on the subject's own characteristics or behaviors. The locus of causality dimension seems to correspond to Rotter's generalized internal/external locus of control.

Weiner distinguishes, however, between locus of causality and control. Whereas locus of causality refers to a general perception of the relationship of between one's characteristics or behaviors and outcomes, Weiner sees locus of control as the perception of whether or not the individual can alter the characteristics or behaviors that produce certain outcomes. Thus, some internal causes (dependent on the subject's characteristics or behavior) may be seen as under the control of the subject (e.g., effort), and some internal causes can be seen as uncontrollable by the individual (e.g., ability).

The stability dimension in Weiner's model refers to the variability of causes. Things such as intelligence and task difficulty may be considered stable causes (invariant), whereas mood or effort may be seen as unstable (variant). Thus, in any particular situation, the control and stability dimensions are combined, and perceived determinants of behavior can be classified as internal/stable (e.g., ability), internal/unstable (e.g., effort), external/stable (e.g., task difficulty), and external/unstable (e.g., luck) (Stipek & Weisz, 1981; Weiner, 1972).

Bandura's perceived self-efficacy concept may relate to Weiner's stability dimension. Bandura (1984) discusses a study conducted with children of high and low perceived mathematical self-efficacy. He reports:

Those who perceive themselves to be highly efficacious attributed their failures to insufficient effort [an unstable factor], whereas those who regarded themselves as inefficacious ascribed their failures to deficient ability [a stable factor] (p. 233).

Thus, Weiner's attribution model may be more helpful than the Rotter model in distinguishing the specific factors that may or may not contribute to perceptions of self-efficacy. Weiner points out, however, that one shortcoming of his classification of the perceived determinants of behavior is that in

some cases, generally unstable factors may be viewed as stable determinants, as in the case of individuals who perceive themselves as generally either diligent or lucky. Also, the Weiner model does not distinguish general from specific ability (Weiner, 1972, p. 356). The Rotter model, then, provides for a very generalized view of the causal relationship between outcomes and behaviors or characteristics.

Another difficulty with using the Weiner model to help explain changes in expectancies in specific situations is that reliable measures of these attributions are not available. Although attributions appear to predict behavior, they seem to vary considerably depending on the question format of the measure (Stipek & Weisz, 1981, p. 121).

In the absence of evidence that the multidimensional model of locus of control is more relevant to computer-related studies than the unidimensional model, and because of the shortcomings of Weiner's classification and the lack of a reliable measure of Weiner's attributes, the present study relies on Rotter's conception of generalized locus of control. It is noted, however, that the Rotter model may not provide for the examination of all the factors which may contribute to the individual's perception of self-efficacy with computers. The Rotter Internal/External Control Scale was used to classify the generalized locus of control of subjects in the present experiment, although the development and use of a goal-specific measure of locus of control related to the use of computers might lead to a clearer understanding of the relationship between locus of control and attitudes towards computers.

Locus of control, for purposes of this present investigation, can be seen, then, as a broad trait conception as opposed to the notion of self-efficacy, which focuses on very specific situational interactions. Concerning self-efficacy, Goldfried and Robins (1982) state:

Although having some similarities to earlier conceptions [LOC], self-efficacy theory is more detailed in the sense that it specifies the nature of the situation and response (p. 362).

Rotter (1966) recognizes the importance of situational variables as well as the generalized expectancy which evolved from past experiences in influencing an individual's perception of the contingency of reinforcement in a particular situation. Rotter notes that the generalized expectancy

seems to have greater importance when a situation is novel or ambiguous, and less importance when the individual has had extensive experience in a particular situation. Thus, for persons who have had little or no previous experience with computers, the generalized locus of control expectancy may interact with instructional methods in affecting perceptions of self-efficacy to a greater degree than for persons who have had a wide range of prior computer experience.

The generalized expectancy for behaviors to produce outcomes or not (internal versus external locus of control) can be crossed with the belief in specific ability to execute behaviors (high or low perceptions of self-efficacy) to produce the following orientations:

Internal locus of control/high self-efficacy: These individuals believe they have the ability to execute specific behaviors, and once executed, desired outcomes will result.

Internal locus of control/ low self-efficacy: Here, the individual believes that outcomes are dependent on behaviors, but there is an inability to perform the necessary actions to obtain those outcomes.

External locus of control/ high self-efficacy: The person feels able to perform particular behaviors, but that the behaviors will not affect what happens.

External locus of control/low self-efficacy: This individual feels unable to perform specific behaviors, and that outcomes would not be affected even if they were performed.

The relationship between generalized locus of control and perceptions of self-efficacy in the specific area of computer use was investigated in this present study. The second and fourth of the orientations described above (internal/low self-efficacy, external/low self-efficacy) were of particular interest.

The Interaction of Locus of Control and Instructional Methods

Most of the research conducted to study the interaction of locus of control and instructional methods has focused on academic achievement. The achievement studies have shown that the effectiveness of different instructional strategies in promoting academic achievement differs for internally controlled and externally controlled individuals.

In the area of mathematics, Horak and Horak (1982) found that internals achieved more when taught using inductive teaching methods, defined as those "based on the presentation to the learner of a sufficient number of specific examples to enable him to arrive at a rule, principle or fact" (Horak & Horak, 1982, p. 18). Externals achieved more when taught with deductive methods, characterized as those that proceed "from rules or generalizations to examples and subsequently to conclusion or to the application of the generalizations" (Horak & Horak, 1982, p. 18). The authors suggest that internals feel responsible for their own achievement and therefore exert more effort to structure the material for themselves, while externals feel more comfortable when the teacher assumes the responsibility for setting the pace of instruction and summarizing the pertinent rules. Thus, inductive methods are more congruent with the way internals approach learning situations, whereas deductive methods compliment the external's approach.

Daniels and Stevens (1976) contrasted a teacher-controlled method of instruction (lecture, assigned reading, weekly quizzes) with a student-controlled method (contract for a grade plan with discussions and class project) and tested the interaction of these with locus of control. A strong interaction was found, with internals performing better under the student-controlled method and externals performing better under the teacher-controlled method.

Two other studies have found that internals achieve more when they are placed in low structured or low disciplined instructional settings, whereas externals tend to do better in high structured or high disciplined settings (Horak & Slobodzian, 1980; Parent, Forward, Canter & Mohling, 1975). Pines (1973) and Pines and Julian (1972) have found that internals tend to be more active information processors and are better able to call on previous information in decision-making tasks than are externals. Parent, Forward, Canter and Mohling (1975) suggest that these behaviors seem to be ones that should discriminate persons with high or low internalized discipline. The results of the Horak and Slobodzian, and Parent, Canter, Forward and Mohling studies indicate that students achieve at optimal levels when there is a complimentary fit, or congruence between students' levels of internalized discipline and the external conditions of discipline inherent in the learning situation.

The research cited above has shown that the generalized expectancy of locus of control interacts with teaching methods in affecting levels of achievement. Whether or not this interaction remains the same in affecting perceptions of self-efficacy has not been researched.

The congruence between locus of control and task instructions has been found to relate to the amount of effort expended to solve problems. Minor and Roberts (1984) found that when the instructions for a task included the suggestion that success was dependent on skill, internals expended greater effort, whereas externals expended more effort if the instructions indicated that success was based on chance. If, as Bandura posits, the amount of effort expended is dependent upon perceived self-efficacy, then this study supports the idea that there is an interaction between LOC and instructional design that affects self-efficacy perceptions. The weakness of the Minor and Roberts study is that skill or chance elements were artificially imposed only through task instructions rather than being part of the task itself.

In an earlier study than the Miner and Roberts investigation, Brice and Sassenrath (1976) examined the question of whether perceptions of the skill or luck nature of the task would affect expectancy for success. They found that internals have a greater expectancy of success when they see the task as skill-based, and externals have a greater expectancy of success if the task is perceived as chance or luck-based. In this case, it was found that the relationship between LOC (generalized expectancy) and self-efficacy expectations (specific expectancy) was based solely on subjects' perception of the particular situation, not just on task instructions.

The findings reported above are at least consistent with the hypothesis that when tasks are perceived as congruent with locus of control, greater perceptions of self-efficacy are the result. Specifically, internally controlled individuals may be predicted to have greater perceived self-efficacy for tasks that are seen as under personal control; and external individuals may be predicted to have greater perceived self-efficacy for tasks that are seen as beyond personal control. The experiment in the present study was designed to test the hypothesis. Two treatments were devised varying in instructional approach and conditions of discipline (inductive, low structure, low

discipline/deductive,high structure, high discipline). Effects of these treatments on the self-efficacy of persons with internal versus external locus of control were assessed.

Self-efficacy and/or Locus of Control and Computer Education

In examining the effects of locus of control in computer literacy instruction, one study (Wesley, Krockover & Hicks, 1985) examined the interaction of locus of control with two different modes of programmed instruction, CAI (computer-assisted instruction) and a text or print mode. The instructional method of each treatment was the same, the only difference being the media chosen to deliver the instruction (the computer versus text). In both cases, information was presented in a logical sequence of small steps, with active participation required in the form of questions after presentation of each subunit of information. Students in the text group could compare their answers with an answer key at the end of the lesson, whereas students in the CAI group received immediate feedback via the computer monitor. Quizzes at the end of the lessons were included to provide feedback about progress. CAI students received immediate feedback from the computer; graded quizzes were returned to the text students during the next class session.

The findings were that the subjects rated as externally controlled achieved significantly higher scores on the cognitive scale of the *Minnesota Computer Literacy and Awareness Assessment* after lessons taught using the computer. For internally controlled subjects, no differences in treatments were observed. The authors suggest that these differences may be due to the fact that more internals than externals had prior experience with computers. Consequently, the treatment effect of the CAI on achievement of knowledge about computers for externals was greater by virtue of merely providing exposure to computers. This hypothesis is also consistent with Rotter's belief that the generalized expectancy of locus of control has greater importance in novel situations than when individuals have had prior experience with the conditions of the experience.

Concerning the effects of locus of control on affective responses towards computers, Coovert & Goldstein (1980) found that an individual's locus of control orientation served as a predictor of attitudes

towards computers in two different experiments. The results of both experiments indicated that internals had significantly more positive (favorable) attitudes than externals.

The results of the Coovert and Goldstein study and the Wesley, Krockover and Hicks study suggest that planning for computer literacy instruction is even more critical for externally controlled individuals than it is for their internally controlled peers. The nature of initial experiences that internal and external student teachers have with computers may need to be varied to take differing attitudinal factors into account. Experiences for externals that are designed to specifically address the affective dimension may increase the likelihood that externals will choose to become "computer literate" by enrolling in further courses.

While researchers in computer education have not specifically addressed Bandura's concept of perceived self-efficacy, Battista and Krockover (1984) have assessed the affective and cognitive effects of different computer activities using the *Minnesota Computer Literacy and Awareness Assessment*. This measure includes questions assessing the attitudinal dimension of perceived self-efficacy and other attitudinal factors, as well as questions concerning knowledge about computers.

In the Battista and Krockover study, preservice teachers were assigned to two treatment groups, computer programming and computer assisted instruction (CAI). After treatments, the subjects attitudes and knowledge about computers were assessed. For subjects in the programming group, the performance demands placed on them were significantly greater than for subjects in the CAI group. The programming language used was BASIC, and after one initial assignment that required students to enter and run several short programs demonstrating various aspects of the language, the students were required to choose one of several problems and solve it using the computer. The treatment emphasized independent learning by experimentation with the computer.

Students in the CAI group, on the other hand, used computers in a way that was more similar to regular learning experiences. They were required to take four quizzes on assigned reading and laboratory experiments on the computer and to participate in three earth science computer simulation activities. Subjects in the CAI group received direct instruction about how to use the computer for

these activities and the programs were loaded into the computer by the instructor. The computer served only as a mode of presentation for instruction.

Battista and Krockover concluded that computer programming activities had little or no effect on either preservice teachers' knowledge about (cognitive domain) or attitudes towards (affective domain) computers. Computer-assisted instruction (CAI) activities had a significant positive effect on their attitudes towards computers (affective domain) and a positive effect in the cognitive domain.

In light of Bandura's self-efficacy theory, the results of the Battista and Krockover study are not surprising. The content of the two treatments in this study, as well as the difficulty level, situational circumstances, and amount of external aid received, were substantially different for subjects in this experiment. Subjects in the programming group were placed in a novel situation where initial performance demands, without benefit of external aid, were high. Subjects in the CAI group had experiences that were less novel (e.g., taking quizzes) and had direct help from the instructor in using the computer.

Another problem with the Battista and Krockover study is that the groups were two intact classes with different instructors and content. Attitudes towards the instructors, or the class in general, may have contaminated the results. From these findings it is difficult to assess the effects of these different computer activities on perceptions of self-efficacy with computers since the study is limited, and flawed by the lack of control over the critical variables as identified by Bandura. Additionally, the possible interaction between generalized locus of control and these two instructional methods was not investigated.

Summary

Bandura's self-efficacy theory and Rotter's locus of control theory form the theoretical basis for this present study. Self-efficacy theory states that efficacy expectancies have to do with whether or not individuals feel that they can perform necessary actions to produce desired outcomes. Perceptions of self-efficacy influence choice of activities, amount of effort expended and persistence in the face of

difficulties in any task situation. It is predicted, then, that pre-service teachers who have a high sense of self-efficacy with computers will be more likely to engage in computer education activities and thus will become more effective users of computers in their future classrooms. Although providing a practical rationale for the present study, this issue is beyond the scope of this current investigation.

The most reliable source of efficacy expectations is performance accomplishment. In experiences designed to enhance perceptions of self-efficacy, the amount and variety of self-directed performance will determine the generality and durability of the efficacy expectations. Other factors that will influence the effectiveness of efficacy expectation-enhancing treatments are perceptions of the difficulty of the task, the situational circumstances, and the amount of external aid that subjects receive. In this study, the treatments were designed to control for difficulty level, amount of external aid, and situational circumstances. What varied between treatments was the level of control over the instruction that students had and the amount of self-directed performance provided for in each treatment (see Chapter 3 for a more detailed description of the treatments).

Bandura's concept of perceived self-efficacy can be viewed as a more detailed and specific trait conception than Rotter's concept of locus of control. According to Rotter's theory, locus of control is seen as a generalized expectancy for internal versus external control of reinforcements. Internals are those people who view the outcomes of their behavior as resulting from their own effort and ability, and thereby under personal control. Externals attribute both positive and negative reinforcements to forces beyond their control such as luck, fate, or significant others. The focal point in locus of control theory is on generalized expectancies, whereas the focus in self-efficacy theory is on specific expectancies. This study investigated the relationship between generalized locus of control and specific perceptions of self-efficacy with computers.

Internal locus of control has been correlated with higher achievement (Hill, 1978; Stipek & Weisz, 1981) and with the personality characteristics of assertiveness, confidence, and high self-esteem (Hill, 1978). It has been shown that locus of control interacts with instructional methods in academic achievement in non-computer and computer related areas. Additionally, researchers have demonstrated the interaction of locus of control and task design in producing differences in the amount of effort

expended on the task (Minor & Roberts, 1984; Brice & Sassenrath, 1976), which may be seen as a reflection of self-efficacy expectations. Although one study (Battista and Krockover, 1984) reported affective differences (including perceived self-efficacy) between two different instructional methods using computers, there was no control over the critical variables that may have produced the differences (those identified by Bandura), and the possible interaction of locus of control was not examined.

The present study was designed to extend the research in the area of locus of control, self-efficacy and instructional methods. Based on the research cited in this chapter, it was hypothesized that there would be an interaction between generalized locus of control and instructional methods in activities designed to enhance self-efficacy in the area of computer use. For internally controlled subjects, initial computer activities that are based on the inductive approach in a relatively low-structured situation that provide for greater student control and opportunities for self-directed performance were expected to enhance perceptions of self-efficacy, whereas externals' self-efficacy would be better enhanced by activities that are more highly structured, program-controlled and which use a deductive approach. The results of this study will contribute to a better understanding of the relationship between these important variables.

CHAPTER 3

METHOD

Introduction

The present experiment was designed to determine if there is an interaction between locus of control and instructional method in experiences designed to enhance perceived self-efficacy. The independent variables in this investigation were locus of control (internal/external) and instructional method (student-controlled/program controlled). The dependent variable was perceived self-efficacy as measured by the affective subscales of the *Minnesota Computer Literacy and Awareness Assessment* (MCLAA). The experimental data for this investigation were collected during the Spring term of 1986 at Western Oregon State College in Monmouth, Oregon.

This chapter describes: (a) the selection of the sample, (b) the design of the study, (c) the instruments used to measure locus of control and perceived self-efficacy, (d) development and field test of the treatments, (e) the procedures for administration of the treatments and gathering of the data, and, (f) the data analysis procedures.

Subjects

The sample for this experiment consisted of college students enrolled in three required courses for Teacher Education majors at Western Oregon State College (N = 128). Western Oregon State College is a coeducational liberal arts college with an enrollment of about 2,800 students. While it draws students from throughout the state of Oregon, there are few minority students, and the population of out-of-state and foreign students is small.

All subjects in the present experiment were enrolled during Spring term, 1986 in three separate courses. Ed 361 and Ed 362, (second and third terms of a three term sequence, Learning and

Instruction in the Elementary Schools) are required courses for all elementary education majors. Ed 435 (Educational Media and Materials), is a required course for all secondary education majors.

The total percentage of males (32%) and females (68%) in this sample is consistent with the general demographics of the population in the school of education at Western Oregon State College, as well as other schools of education throughout the country. Age data were collected by respondents selecting the appropriate age category: 18 and under, 19 or 20, 21 - 24, 25 - 30, over 30. The majority of the subjects (41%) fell into the 21 - 24 category, with the next highest number indicating the over 30 category (27%). No subjects fell into the 18 and under group.

The three courses from which subjects were drawn are intended for upper division students. The sample consisted of 45% seniors, 36% juniors, 16% graduates, and 3% sophomores.

Design of the Study

The experiment used a two by two factorial design with locus of control (internal and external) as one independent variable and instructional method (program-controlled and student-controlled) as the second independent variable. The dependent variable of perceived self-efficacy was examined (total score on the affective scale of the MCLAA), as well as four separate dependent variables corresponding to the four subscales of the affective scale of the MCLAA, titled (1) anxiety, (2) enjoyment, (3) efficacy, and, (4) educational computer support.

The Campbell and Stanley (1963) Posttest-Only Factorial Design was selected for this experiment. Its form is as follows:

R	X ₁	O
R	X ₂	O

where R = Random assignment

X₁ = Treatment 1

X₂ = Treatment 2

O = Observation or measurement of
the dependent variable

The main strength of this design over the potentially more powerful Pretest-Posttest Factorial Design is that it controls for possible pretest contamination. Campbell and Stanley (1963) point out that this is particularly important when the dependent variable is an affective measure.

Instruments Used

The instruments used in this investigation were paper and pencil tests. They were:

(1) *The Rotter Internal/External Control Scale* (see Appendix A). This is a 23-item forced choice questionnaire with a higher score representing a more external personality. It also contains six filler items designed to make the test's purpose less obvious. The test is considered to be a measure of a generalized expectancy for either internal or external control of reinforcements (Rotter, 1966, p. 10).

Internal consistency of the Rotter scale, as measured by the Spearman-Brown split half correlation method, is reported to range from .65 - .79 (Rotter, 1966, p. 13). Test-retest reliability (382 subjects) is reported to range from .49 -.83 (Rotter, 1966, p. 13).

This measure was chosen because it was normed on undergraduate students who should have possessed many of the characteristics of subjects in the present investigation. Additionally, it was the most frequently used measure of locus of control in the the research reviewed in Chapter 2 (Brice & Sassenrath, 1978; Horak & Horak, 1982; Minor & Roberts, 1984; Parent, Forward, Canter, & Mohling, 1975; Stake, 1979).

(2) *The Minnesota Computer Literacy and Awareness Assessment (MCLAA)* (see Appendix B). The MCLAA measures subjects' affective and cognitive knowledge of computers. Two forms of this measure (Form 1 and Form 8) were originally developed (for grade 11 and grade 8 and higher, respectively). Form 8 was the only one available at the time of the experiment, and the affective portion of that form was used in the investigation.

The affective scale of Form 8 of the MCLAA consists of a total of 20 items which measure the following attitudes and values (Anderson, R.E., Klassen, D.L., Johnson, D.C., & Hansen, T.P. , 1982):

Enjoyment . The degree to which a student enjoys computers or learning about computers.

Anxiety . The level of anxiety or stress that is associated with dealing with computers.

Efficacy. The extent to which a student feels confident about his or her ability to deal with computers.

Educational Computer Support. The degree to which a student feels positive towards the integration of computers into the educational system.

The intercorrelations of these subscales, conducted by Anderson, Hansen, Johnson, and Klassen (1982), are shown in Table 1.

Table 1
Intercorrelations of the Affective Subscales of the MCLAA

	Anxiety	Enjoyment	Efficacy	Educational Computer Support
Anxiety	1.000	-.40	-.50	-.26
Enjoyment		1.000	.55	.50
Efficacy			1.000	.40
Educational Computer Support				1.000

Note. Negative correlations for the anxiety subscale result from reverse wording of these items.

The construct validity of the affective subscales of Form 8 of the MCLAA was assessed through a factor analysis (Anderson, Klassen, Johnson, & Hansen, 1982). The factors described above

were identified with the order of strength (from strongest to weakest) being, (1) enjoyment, (2) anxiety, (3) educational computer support, and (4) efficacy.

Battista and Krockover (1984) and Wesley, Krockover and Hicks (1985) report the overall reliability of the affective scale of the MCLAA to be .83 (Cronbach Alpha, 94 subjects) and .93 (Spearman-Brown, 81 students) respectively. These reliabilities are consistent with those reported by Anderson, Klassen, Johnson, and Hansen (1979b). Separate reliabilities on the four subscales of the affective scale described above are reported to be: enjoyment, .81; anxiety, .64; efficacy, .60; and educational computer support, .66 (Anderson, Klassen, Johnson, and Hansen, 1982). Although these reliabilities are moderate to low, the MCLAA was the best measure available that addressed the factors relevant to the present study.

Development and Field Test of the Materials

The Materials

The two treatments used in this experiment were developed by the investigator at the Oregon State University/Western Oregon State College School of Education. Both were designed to be instructional modules for students to work through on an individual basis. Module One (program-controlled) was developed during Winter term, 1986. Module Two (student-controlled) was developed during Fall term, 1984. A description of the two modules follows.

Module One : Program-controlled

The lesson uses a deductive approach, in which students are first introduced to rules or generalizations concerning the Logo language, and then provided with specific examples of the commands. Application of the rules is then covered in the question sections in which students respond to multiple-choice items. Correct responses are followed by a brief congratulatory message (e.g. "You're Right!", "Good Answer!"), and then a demonstration of each of the answer choices, followed by a restatement of the correct answer. In the case of an incorrect response, no feedback message is

given, and the program proceeds directly to the demonstration of each answer choice and then the restatement of the correct answer.

Students have relatively little control over the pace of the lesson in this module. The computer program and audio taped narration proceed through an explanation of the concepts without interaction from the user. Thus, the pace of the lesson is dictated by the program. Interaction occurs only during the question segments, and during these, students can have an unlimited amount of time to respond to the questions. The lesson is highly structured, with no opportunity for students to practice using the Logo commands on their own. The performance requirements for this task using the computer consist of loading the Logo language and the lesson program into the computer memory (the student is advised that the lab assistant will help with this if necessary), pressing the RETURN key to synchronize the computer program with the audio narration, watching the program on the monitor while listening to the taped narration, and responding to multiple-choice questions by typing the number corresponding to their answer choice followed by pressing the RETURN key.

This self-instructional module includes:

- (a) A four-page printed article entitled "Explorations in Logo" adapted from *The Computer: A Tool for the Teacher* (Wright & Forcier, 1985). This article introduces students to the philosophy and learning theory on which the Logo computer programming language is based. Additionally, it describes how Logo is introduced to children, discussing the beginning Logo commands (Appendix C).
- (b) A language diskette containing the Logo computer-programming language.
- (c) A lesson-diskette containing a program which demonstrates commands in the Logo language. The lesson is divided into four sections, with each section followed by a review set of questions (full description, Appendix D).
- (d) An audio-cassette tape which provides a narrative while students work through the program on the computer (transcript, Appendix E).

The hardware used for Module One consisted of an Apple IIe computer, monitor and disk drive, and an audio-cassette player with headphones.

Module Two: Student-controlled

The lesson for Module Two uses an inductive approach. Students are introduced to the Logo commands through the use of specific examples. They are required to type in commands specified on the audio tape, and then observe the results. Cards corresponding to these are included in the packet to show how they should be entered and what the results should look like on their screen (see Appendix F). Then students are encouraged to arrive at general rules or principles of the language through self-directed exploration of these commands. They are instructed to pause the audio tape and explore using the commands in any way they like.

Students using the module have a relatively high degree of control over the pace of the lesson and what they experience with the computer. The lesson is relatively low-structured, providing many opportunities for self-directed performance with the computer. The performance requirements using the computer for this lesson consist of loading the Logo language into the computer memory (help is provided with this if necessary) and then entering Logo commands into the computer for execution.

Module Two includes:

- (a) The same four-page article ("Explorations in Logo") as in Module One.
- (b) A language diskette containing the Logo computer-programming language.
- (c) An audio-cassette tape which provides narrative and instructions for students as they work with the Logo language on the computer (transcript, Appendix F).
- (d) A set of 25 reference cards corresponding to the taped narration which duplicate what the user should see on the computer monitor during the lesson (Appendix G).
- (e) A "Turtle Talk Reference Sheet" which lists the Logo commands introduced in the lesson with examples and descriptions of what each does (Appendix H).

The hardware used for this module is the same as in Module One (an Apple IIe computer, monitor and disk drive, and an audio-cassette player with headphones).

The content, difficulty level and amount of external aid subjects receive in using the computer are the same in both the program-controlled and student-controlled modules. Both introduce the student to the same Logo commands and offer a description of the learning theory and philosophy on which Logo is based. Results of the field test of these modules indicate that students perceive the difficulty level of the lessons to be roughly equivalent (see next section for a more thorough discussion of the field test). While the performance requirements for the student-controlled module are greater than for the program-controlled module, each provides a maximum amount of external aid in specifying exactly what students need to do in order to proceed through the lesson using the computer.

Differences in the modules center on the level of control over the lesson that students have, and the overall instructional approach of the lessons. Module One uses the deductive approach and is highly structured: the method that has been shown to be more congruent with an external locus of control. It provides for minimal control of the lesson by the user and little opportunity for self-directed performance with the computer. The lesson in Module Two uses the inductive approach and is low-structured: shown to be more congruent with an internal locus of control. It provides for a high degree of control of the lesson by the user and many opportunities for self-directed performance with the computer.

Field Test of the Treatments

A field test of the two treatments was conducted at Western Oregon State College during Fall term, 1985 and Winter term, 1986. A total of 34 students from two sections of Ed 435 (Educational Media and Materials) volunteered to participate in this experiment (17 students in the program-controlled group and 17 students in student-controlled group).

The field test was designed to compare the time-on-task requirements for each module, and the perceived difficulty and interest level of each lesson. Students recorded starting and finishing time on an evaluation sheet, and after completion of the self-instructional modules, rated the difficulty and interest level of the lesson/module using a five-point Lickert scale (1 - Very easy/not very interesting,

5 - Very hard/very interesting). Results from the field-test are summarized in Table 2 (also see Appendix I).

Table 2
Time, Difficulty and Interest Levels of Modules

	Module One (Program-controlled)	Module Two (Student-controlled)
Mean Time	40.9 minutes	58.7 minutes
Mean Difficulty	2.00	2.07
Mean Interest	3.29	3.24

The results of the field test of the modules indicate that the difficulty and interest levels of each module are consistent. Mean difficulty levels were calculated to be 2.00 for Module One, and 2.07 for Module Two. Interest levels for Module One and Two were 3.29 and 3.24 respectively. Bandura's variable of the difficulty of the task has thus been controlled in the treatments. The difference in mean time-on-task can be attributed to the fact that students in Group Two (student-controlled module) had the opportunity for an unlimited amount of self-directed performance, whereas the amount of time spent in the program-controlled module (Group One) was more closely controlled by the program.

Procedures for Administration of Treatments and Data Collection

Administration of the treatments and data collection for the experiment took place between January 8 and June 4, 1986. Students in Ed 361 completed the Rotter Internal/External Control Scale during the first class meeting of the 1986 Winter term (January 8, 1986). Students in Ed 361 and Ed 435 completed the Internal/External Control Scale during the first class sessions of the 1986 Spring

term (April 1 and 2). In order to characterize the sample, students also completed questionnaires, reporting such data as their age, class status, and previous computer experience.

The range of scores on the Rotter Internal/External Control Scale was from 1 to 23 (midpoint = 11). All students who scored below 11 were classified as internals, and those scoring above 11 were classed as externals. Students who scored exactly 11 were randomly classified, using a table of random numbers (Borg & Gall, 1983), as either internal or external. This yielded a total of 76 internals and 52 externals.

After blocking for the internal/external classification, using a table of random numbers (Borg & Gall, 1983), students were then randomly assigned to two treatment groups (Program-controlled Instructional Method/ Student-controlled Instructional Method). Distribution of the total sample of internal and external subjects into treatment groups is shown in Table 3.

Table 3
Distribution of Internal/External Subjects
in Treatment Groups

Locus of Control	Instructional Method	
	Program-controlled	Student-controlled
Internals	38	38
Externals	26	26

Of this sample, a total of 95 subjects completed all phases of the experiment. The distribution of these subjects in the treatment groups, with gender indicated, is shown in Table 4.

Table 4
Distribution of Internal/External Subjects
in Treatment Groups by Gender

Locus of Control	Instructional Method			
	Program-controlled		Student-controlled	
	n	%	n	%
Internals				
Males	11	39	11	42
Females	17	61	15	58
Externals				
Males	5	26	3	14
Females	14	74	19	86

Distribution of subjects by age and class standing are shown in Appendixes J and K.

Procedures for completion of the modules were identical for each group in the experiment, thus controlling for Bandura's variable of situational circumstances. During the 2-week treatment period assigned for each class, students reported to the Learning Activities Resource Center (LARC) on campus to complete the assigned instructional modules. These were treated as an out-of-class assignment for all students enrolled in the courses. Two stations for each instructional module, with an Apple IIe computer, disk drive and monitor, and audio cassette player with headphones, were arranged. The stations for each of the two module types were separated by four other computer

stations not used in this experiment in order to avoid contamination by subjects observing the module not assigned to them.

Students checked-out the self-instructional module for their group from the LARC assistant, then proceeded to the appropriate station to work through the lesson on an individual basis. Step-by-step directions for each module were listed on the front of the module package. Upon completion of the lesson, students returned the package to the LARC assistant, and their names were crossed off a master list of students for that class.

The procedures were tested during the field study of the treatments, and were found to be generally effective and efficient. An extended interview of four randomly selected students of the 34 who participated in this field study indicated that most felt comfortable with the system and procedures. One student felt that there were too many different media involved, and that it would have been better to eliminate the audio cassette taped narration. Further questioning revealed that this student was not comfortable with an auditory presentation of information. This suggests that students who are more visually oriented may have had difficulty with the self-instructional modules by virtue of the fact that much of the information presented in each module was delivered via the audio taped narration.

During the first class session after the 2-week treatment period for each class, the affective subscale of the MCLAA was administered to all students. This was done by the regular course instructor in the large group class setting.

Data Analysis Procedures

The data from this experiment were analyzed with analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) (see Chapter 4). Although the level of $p \leq .05$ was used to determine the statistical significance of the results of the experiment, a $p \leq .10$ was considered meaningful because of the relatively small sample size and exploratory nature of this study. Additionally, the observed differences between the means were examined in order to assess general

directions of the results in the absence of statistical significance.

CHAPTER 4

ANALYSIS OF THE DATA

Introduction

The statistical tool of two-way fixed analysis of variance (ANOVA) was used to examine the interaction effects of locus of control and instructional method on the subjects' perceived self-efficacy (total affective score on the MCLAA). Multivariate analysis of variance (MANOVA) was used to examine the interrelations between anxiety, enjoyment, efficacy and educational computer support (4 subscales of the affective portion of the MCLAA) in the possible interaction with locus of control and instructional method.

Subjects' responses to the two instruments (the *Rotter Internal/External Control Scale* and Questionnaire, and the affective subscales of the MCLAA) were recorded by the subjects on machine-scored answer sheets. This information was compiled and entered into a data-base using a Macintosh computer and the Microsoft File program. The data were then transferred to the CYBER computer system at Oregon State University for analysis using the SPSS (*Statistical Package for the Social Sciences*) program.

Data Entry

The source of data for the dependent variables was the affective portion of the MCLAA, titled "Computer Questionnaire" in this experiment (see Appendix D). Item numbers corresponding to the four subscales are listed below:

Anxiety: items #2, #3, #4, #8, #9
Enjoyment : items #1, #5, #6, #7, #10
Efficacy: items #11, #12, #13, #14, #15
Educational Computer support: items #16, #17, #18, #19, #20.

Subjects responded to these items on a 5-point Lickert scale, scored 1 - 5 (from strongly disagree to strongly agree). All items from the anxiety subscale were reverse scored in order to reflect the proper relationship to the other subscales in the total affective score. In addition, items #12 and #15 from the efficacy subscale, and item #20 from the educational computer support subscale were reverse scored as dictated by the authors of the MCLAA (Anderson, Klassen, Johnson & Hansen, 1982, p. D -18). The sum of all items for each subscale was recorded in the database in fields for each of these variables, as well the sum of all subscales (total affective score).

Total Perceived Self-efficacy Results

The mean scores for each group on total perceived self-efficacy (total affective score from the MCLAA) are shown in Table 5. The observed differences between the means indicate that the results of this experiment tended to move in the expected direction.

Table 5

Means of Total Perceived Self-efficacy Scores by Group

Locus of Control	Instructional Method	
	Program-controlled	Student-controlled
Internals	74.21	76.62
Externals	77.58	76.50

Subjects who were instructed with methods that were more congruent with their locus of control orientation had slightly higher mean scores on the measure of perceived self-efficacy. The means for internal subjects who were taught using the student-controlled method ($M = 76.62$) were

higher than the means for internals taught with the program-controlled method ($M = 74.21$). For external subjects, mean scores were higher for those in the program-controlled group ($M = 77.58$) than for externals in the student-controlled group ($M = 76.50$). This suggests that there may be some, albeit slight, interaction between locus of control and instructional methods which affects perceived self-efficacy.

To examine the effects of locus of control (internal/external) and instructional method (program-controlled/student-controlled) on the subjects' total perceived self-efficacy (total affective score from the MCLAA), a two-way (2 locus of control by 2 instructional method) fixed analysis of variance was used. The ANOVA yields information about the main effects of both locus of control and instructional method, as well as providing information about the interaction effects of these variables. Table 6 presents a summary of the analysis of variance.

Table 6
Analysis of Variance of the Total Perceived
Self-efficacy Scores on the MCLAA

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significance of F
Locus of Control	1	58.00	58.00	.42	.52
Instructional Method	1	19.29	19.29	.14	.71
2-Way Interactions	1	70.30	70.30	.51	.48
Error	91	12615.00	138.63		
Total	94	12766.48			

The ANOVA results indicate that the observed differences as shown in Table 5 are not statistically significant at the .05 or .10 level. As is indicated in Table 6, no significant differences in the means for main effects or interaction effects resulted from the present experiment. Thus, the hypothesis that there would be an interaction between locus of control and instructional method in activities designed to enhance self-efficacy with computers is not supported statistically by these results.

Results from the Subscales

Because the reported intercorrelations of the four affective scales on the MCLAA were moderate to low ($r = .60 - .81$), the statistical tool of multivariate analysis of variance was also employed. MANOVA is quite similar to analysis of variance. The major difference is that the MANOVA technique determines whether several groups differ on two or more dependent variables when considered together (Borg & Gall, 1983, p. 554). In this case, the MANOVA accounts for the interrelations between the four dependent variables (anxiety, efficacy, enjoyment, educational computer support) and through the calculation of a multivariate F , indicates possible group differences in terms of these variables when considered together. If main effect or interaction effect multivariate F -tests suggest group differences, univariate F -tests can be inspected to find specific dependent variable differences. Table 7 summarizes the results of three different multivariate tests of significance that were performed with the SPSS program.

Table 7
Results of Multivariate Tests of Significance

Test Name	Value	Approximate F	Hypothesis DF	Error DF	Significance of F
Pillais	.03	.71	4.00	88.00	.59
Hotellings	.03	.71	4.00	88.00	.59
Wilks	.97	.71	4.00	88.00	.59

All three multivariate tests of significance indicated that at the .05 or .10 level there was no significant statistical interaction between locus of control and instructional method that affected the 4 variables of anxiety, enjoyment, efficacy and educational computer support when considered together.

Even though the multivariate F did not meet the .05 or .10 level of significance criterion, further inspection of the univariate F for the independent variable of locus of control suggests that differences between internal and external subjects approach significance ($p = .078$) on the anxiety subscale, as shown in Table 8.

Table 8
Univariate F-tests for Locus of Control Effect

Variable	Hypothesis SS	Error SS	Hypothesis MS	Error MS	F	Significance of F
Anxiety	51.87	1482.88	51.87	16.30	3.18	.078*
Enjoyment	3.26	1341.09	3.26	14.74	.22	.639
Efficacy	5.77	1259.93	5.77	13.85	.42	.520
Educational Computer Support	16.11	830.41	16.11	9.13	1.77	.187

* $p \leq .10$

An examination of the means for externals and internals on the anxiety subscale reveals that externals had greater anxiety after treatments than did internals (see Table 9).

Table 9
Means of Anxiety Subscale Scores by Group

Locus of Control	M	Instructional Method	
		Program-controlled	Student-controlled
Internals	17.17	17.00	17.35
Externals	18.66	18.58	18.73

Reliability and Validity

To reassess the validity of the affective portion of the MCLAA, Pearson correlation coefficients were calculated on the results of this experiment. As shown in Table 10, the four subscales of the affective portions of the MCLAA are positively intercorrelated. The coefficients are moderate to high and statistically significant for all correlations but anxiety/educational computer support.

Table 10

Results of Pearson Correlation Test on Four Subscales of the MCLAA

	1	2	3	4
1. Anxiety	1.000	.452*	.751*	.225
2. Enjoyment		1.000	.636*	.558*
3. Efficacy			1.000	.440*
4. Educational Computer Support				1.000

* $p \leq .001$

The results of the Pearson correlation test on the data from the present experiment are consistent with the intercorrelations reported by Anderson, Klassen, Johnson and Hansen (1982). Although negative correlations for the anxiety subscale were reported in the Anderson et. al. study (1982), it has been previously noted (Chapter 3) that these resulted from reverse wording of the anxiety items in the scale. For the purposes of the present experiment, data from these items were reverse scored to reflect the proper relationship of anxiety to the other subscales in the total perceived self-efficacy score.

The high correlation between anxiety and efficacy ($r = .751, p \leq .001$) suggests that these scales are measuring some similar quality. It is interesting to note, however, that the means of internals versus externals on the efficacy subscale do not reflect the general relationship noted on the anxiety

subscale between the quality being measured and locus of control . As shown in Table 11, the total for internals ($\bar{M} = 17.20$) is not very different from the total for externals ($\bar{M} = 17.70$) on the efficacy subscale.

Table 11
Means of Efficacy Subscale Scores by Group

Locus of Control	\bar{M}	Instructional Method	
		Program-controlled	Student-controlled
Internals	17.20	16.86	17.54
Externals	17.70	18.05	17.36

What the means on the efficacy subscale do show is that the interaction between locus of control and instructional method tends in the expected direction: internals and externals after treatments congruent with locus of control had higher mean scores for efficacy than subjects having treatments with methods incongruent with locus of control.

The reliability of the total affective scale and of each of the affective subscales of the MCLAA were reassessed for the subjects in this experiment. The Spearman-Brown method was chosen as the tool for this assessment. For the total affective scale, reliability was calculated to be .89. Reliabilities for the 4 subscales were: anxiety, .71; enjoyment, .82; efficacy, .81; educational computer support, .68.

A post-hoc analysis of covariance on the data from this experiment was conducted in order to assess the effects of completion of prior coursework about computers on total perceived self-efficacy. The results of this analysis revealed a significant effect ($p \leq .001$) for prior coursework about

computers on perceived self-efficacy. Both internal and external subjects who had taken courses in computer programming and/or computer applications scored higher on the measure of perceived self-efficacy than students who had not taken such courses.

CHAPTER 5

SUMMARY AND CONCLUSIONS

In this chapter, the experiment will be briefly summarized, and the conclusions will be stated. Limitations of the study will be discussed and suggestions for further research will be offered.

Summary

The purpose of this experiment was to investigate the interactive effects of locus of control and instructional method on perceived self-efficacy with computers. Perceived self-efficacy involves the belief on the part of individuals that they have the ability to successfully perform actions that will produce specific outcomes.

The two instructional methods in this experiment were intended to represent variations in the amount of control over the lesson that students would have, the amount of self-directed performance opportunities that would be provided in the activity, and to contrast inductive and deductive teaching methods using the computer. The treatments were identified by the names "student-controlled" and "program-controlled".

The two instructional methods were designed to be congruent with two generalized locus of control orientations, "internal" and "external". Internal persons are those who believe that they have control over events in their lives, that what happens to them is due to their own effort and ability. External persons are those who feel that events in their lives happen because of luck, fate or significant other persons. Externals do not believe that they have much control over what happens to them.

The general hypothesis was that subjects who receive instruction using computers by a method that is more congruent with their locus of control orientation would have greater perceptions of self-efficacy about using computers than subjects who experience instruction by methods that are incongruent with their locus of control orientation.

The review of the literature indicated that this general hypothesis is not unreasonable. The evidence (Daniel & Stevens, 1976; Horak & Horak, 1982; Horak & Slobodzian, 1980; Parent, Forward, Canter & Mohling, 1975) suggested that locus of control orientation does interact with instructional methods in some situations, and that different types of computer activities influence both cognitive knowledge and affective feelings about computers in varied ways.

A total of 95 preservice teachers (both elementary and secondary) participated in the experiment. A two-by-two factorial design was used, in which subjects were blocked by locus of control orientation (internal/external) and then randomly assigned to the two instructional methods (student-controlled/program-controlled) yielding four treatment groups. A measure of perceived self-efficacy was obtained from the entire sample following the instructional period. These data were analyzed using appropriate analysis of variance and multivariate analysis of variance procedures.

The results of the test of perceived self-efficacy (affective scale of the *Minnesota Computer Literacy and Awareness Assessment*) were not conclusive. Although there were no statistically significant main effects or interaction effects for locus of control and instructional method, examination of the means for each group indicated that the results tended in the expected direction. Internal subjects who received the student-controlled treatment had higher mean scores than internals in the program-controlled group. External subjects receiving the program-controlled treatment had higher mean scores than externals in the student-controlled group.

Conclusions

The results summarized above were interpreted in the previous chapter, and the following conclusions were drawn from the evidence of this experiment.

- 1) Although the statistical results of this experiment did not achieve significance at the .05 or .10 levels, the observed differences in the means between groups indicate that there may have been some slight interaction between locus of control and instructional methods that affected perceived self-efficacy with computers. Many previous studies (Daniel & Stevens, 1976; Horak & Horak, 1982;

Horak & Slobodzian, 1980; Parent, Forward, Canter & Mohling, 1975) have shown that locus of control does in fact interact with instructional methods in some situations. Congruence, or lack of it, between locus of control and the situational circumstances and performance requirements of differing instructional tasks affects the amount of achievement gained through the instruction. The perception of congruence may be the factor that creates the necessary mindset (including perceptions of self-efficacy for the instructional task) that allows that achievement to happen.

2) Anxiety is highly related to perceptions of self-efficacy with computers. By definition, perceived self-efficacy refers to judgements about the ability to cope with a specific situation. If one does not feel able to cope with a particular activity, that person would feel anxious about engaging in it. The results of this experiment have shown, however, that persons with a generalized external locus of control tended to be more anxious about using computers, than do internally controlled persons after these treatments. This finding supports the conclusion of Wesley, Krockover & Hicks (1985) that planning for instruction or activities with computers is more critical for external students than for their internally controlled peers.

3) Prior coursework in computer programming and /or applications is positively related to perceived self-efficacy with computers. This finding lends further support to the results of earlier research. Carey (1986) found that teachers who take university courses about computers are more likely to use computers with their students. Requiring computer courses at the preservice level may help to insure that teachers would develop the necessary perceptions of self-efficacy that would encourage them to incorporate computers into their instructional programs.

Limitations of the Experiment

One plausible explanation for the lack of statistical significance in the results of the present experiment is the fact that subjects who fell in the middle of the continuum on locus of control were included in the study. Because of the small available population students were blocked for internality/externality by classifying all those scoring below the mean (11) on the range of scores

obtained on the Rotter Internal/External Locus of Control Scale as "internals" and all those scoring above the mean as "externals". Additionally, subjects who scored exactly 11 were randomly assigned to either the internal or external block. While this method proved successful in producing adequate sample sizes for each group, a finer distinction between internal and external subjects was sacrificed. Other studies (Brice & Sassenrath, 1978; Minor & Roberts, 1984) examining various effects of locus of control orientation have eliminated subjects who scored in the middle third range on the Rotter scale (10 - 17). Thus, the degree of internality and externality of the subjects was higher, and differences between these groups were enhanced.

Another problem related to the sample in the present experiment was that there was no attempt to control for previous experience with computers. It is reasonable to assume that a majority of students who are at the sophomore level and above in college today have had at least some prior experience with computers. Increasingly, computers are being integrated into courses in all disciplines from elementary school through college. Many subjects in the 21 - 24 age group (the largest percentage in this experiment) would have had the opportunity to use computers in high school. Western Oregon State College has required at least one course specifically about computers since 1984.

Since the analysis of covariance on the data from this experiment revealed that prior coursework about computers has a significant effect ($p \leq .001$) on perceived self-efficacy, the lack of control over this variable may have contaminated the results of this experiment. Both internal and external subjects who had taken courses in computer programming and/or computer applications scored higher on the measure of perceived self-efficacy than students who had not taken such courses. Thus, if this variable had been controlled, and only subjects who had no prior experience with computers had participated in the experiment, the results may have been different.

Bandura's studies on perceived self-efficacy focused on phobic populations. All subjects in his studies were those who had low perceived self-efficacy for the activities involved his experiments. A post-test only factorial design was chosen for the present experiment to eliminate any possible pretest contamination, especially important in attitude studies. This design assumes that random assignment

to groups will insure an even distribution of any characteristics under study. But the inclusion of subjects with already moderate to high perceived self-efficacy with computers may have diluted any possible effects that could have been obtained in this experiment if the sample had been limited to only those subjects with low perceived self-efficacy with computers. Additionally, the conclusions that can be drawn from examining the differences in mean scores after treatments between internals and externals on the anxiety and efficacy subscales are limited because there is no way to ascertain initial levels of anxiety or efficacy, and subsequently, the degree of change that may have occurred as a result of the treatments.

An improved measure of perceived self-efficacy used in studies of this kind may also be important. Bandura utilized a "microanalytic" technique for measuring perceived self-efficacy (Bandura, 1981-1984). This involved having subjects rate both their level and strength of perceived self-efficacy for the specific tasks involved in the experiment before, during and after treatment. Although the affective scale of the MCLAA measures attitudes related to perceived self-efficacy with computers in general, the subjects' perceptions about their self-efficacy for the specific tasks involved in this experiment were not assessed. The moderate to high correlations between the subscales of the affective MCLAA suggest to this investigator that the scale may not measure perceived self-efficacy sufficiently enough to determine main effects or interaction effects of locus of control and instructional methods on the variable of perceived self-efficacy.

The *Rotter Internal/External Control Scale* used in the present experiment is a broad measure of generalized expectancies for control over reinforcements. Stipek and Weisz (1981) point out that a more narrowly defined generalized expectancy measure should be more highly correlated with specific behaviors related to the domain of expectancy contained in the measure. Thus, the inconclusive results of this experiment may be due to the inadequacy of the Rotter scale to assess expectancies directly related to behaviors with computers. Rotter's conceptualization and measurement of the motivational variable of perceived control of events may be too broad to produce evidence of the relationship between perceived control, instructional methods and perceived self-efficacy.

There is a problem suggested by the results of the field test of the instructional treatments in the current experiment (see Chapter 3) that may also have contributed to the inconclusive results of this investigation. In order to control for situational circumstances and possible effects of investigator bias, self-instructional methods were used. Both instructional modules in this experiment relied on audio-taped narrations for delivery of information in the lessons, along with the work on the computers. Although it was assumed that the students would know how to effectively use the cassette player, the fact that they were required to coordinate two different pieces of equipment may have complicated the performance requirements of the task. Additionally, for those subjects who do not have strong auditory receptive skills, the necessity to receive information via that modality may have created problems.

The results of the field test of the modules also showed that the difficulty level of each module was fairly low. Since Bandura states that "Mastery of an easy task is redundant with what one already knows" (Bandura, 1981, p. 205), it may be that no new efficacy information for raising efficacy appraisals was present in these treatments. Had the difficulty levels been higher, the possibility that one treatment or the other would promote greater perceptions of self-efficacy for internals and externals may have been enhanced.

Suggestions for Further Research

The characteristics and size of the sample were major limitations of the present experiment. By limiting the sample to only those students with low perceived self-efficacy, and controlling for previous experience with computers, it may be possible to determine the interactive effects of locus of control and instructional method on perceptions of self-efficacy more clearly. Further research using the same or similar methods with a larger sample of persons with these characteristics may prove fruitful in shedding additional light on this topic.

Using a microanalytic technique for measuring perceptions of self-efficacy may lead future investigators to a clearer understanding of the relationship between instructional methods and locus of

control when attempting to alter perceived self-efficacy with computers. Assessments of both the level and strength of self-efficacy perceptions in questions addressing the specific tasks involved in the experiment will allow for a more complete analysis of the relationship between specific instructional tasks and self-efficacy perceptions. Lengthening the treatment periods and performing these assessments before, during and after treatments would yield more data on which to base decisions about the effectiveness of different instructional methods.

The review of the research on locus of control in this study (Chapter 2) has shown that perceived control of events is one motivational variable that affects a variety of behavioral situations. As discussed in Chapter 2, the value of the unidimensional model of locus of control as proposed by Rotter has been questioned by other researchers (Lefcourt, 1981). One study (Coovert & Goldstein, 1980) showed that Levenson's multidimensional model (called Internality, Powerful-Others, and Chance) did not significantly discriminate between different dimensions of externality when examining their relationship to attitudes towards computers. But other theoretical orientations to the conceptualization and measurement of the control variable, such as Weiner's attribution theory or the intrinsic motivation theories of White (1959), Deci (1975) or Harter (1978), may prove to be more fruitful in examining the relationship between perceptions of control and attitudes towards computers. Further research based on other theoretical orientations of perceived control may help to clarify whether or not locus of control orientations interact with instructional methods in affecting perceptions of self-efficacy.

BIBLIOGRAPHY

- Anderson, R.E., Hansen, T.P., Johnson, D.C., & Klassen, D.L. (1979a) . *Minnesota Computer Literacy and Awareness Assessment*. St. Paul: Minnesota Educational Computing Consortium.
- Anderson, R.E., Klassen, D.L., Johnson, D.C., & Hansen, T.P. (1979b) . *The Minnesota computer literacy tests: A technical report on the MECC computer literacy field study*. St. Paul: Minnesota Educational Computing Consortium. (NSF No. SED 77-18658) .
- Anderson, R.E., Klassen, D.L., Johnson, D.C., & Hansen, T.P. (1982). *Assessing computer literacy, computer awareness and literacy: An empirical assessment, Final report*. St. Paul: Minnesota Educational Computing Consortium. (Document #503).
- Bandura, A. (1976) . Effecting change through participant modeling. In J.D. Krumboltz, & C.E. Thorensen (Eds.), *Counseling Methods*. New York: Holt, Rinehart & Winston.
- Bandura, A. (1977a) . Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, 191-215.
- Bandura, A. (1977b) . *Social Learning Theory*. Englewood Cliffs, NJ: Prentice-Hall.
- Bandura, A. (1981) . Self-referent thought: a developmental analysis of self-efficacy. In J.H. Flavell & L. Ross (Eds.), *Social Cognitive Development* (pp. 200-239) . Cambridge, Massachusetts: Cambridge University Press.
- Bandura, A. (1982) . Self-efficacy mechanism in human agency. *American Psychologist*, 37, 122-147.
- Bandura, A. (1984) . Recycling misconceptions of perceived self-efficacy. *Cognitive Therapy and Research*, 8 (3), 231-155.
- Bandura, A. & Adams, N.E. (1977) . Analysis of self-efficacy theory of behavioral change. *Cognitive Therapy and Research*, 1, 287-310.
- Bandura, A., Adams, N.E. & Beyer, J. (1977). Cognitive processes mediating behavioral change. *Journal of Personality and Social Psychology*, 35, 125-139.
- Bandura, A., Adams, N.E., Hardy, A.B. & Howells, G. N. (1980) . Tests of the generality of self-efficacy theory. *Cognitive Therapy and Research*, 4, 39-66.
- Bandura, A., Jeffrey, R. W., & Gajdos, E. (1975). Generalizing change through participant modeling with self-directed mastery. *Behavior Research and Therapy*, 13, 141-152.
- Bandura, A., Jeffrey, R. W., & Wright, C. L. (1974). Efficacy of participant modeling as a function of response induction aids. *Journal of Abnormal Psychology*, 83, 56-64.
- Bar-Tal, D. & Bar-Zohar, Y. (1977) . The relationship between perceptions of locus of control and achievement: Review and some educational implications. *Contemporary Educational Psychology*, (22), 181-199.
- Battista, M.T. & Krockover, G.H. (1982) . A model for the computer education of preservice elementary teachers. *The Journal of Computers in Mathematics and Science Teaching*, 20 (3), 14-17.

- Battista, M.T. & Krockover, G.H. (1984) . The effects of computer use in science and mathematics education upon the computer literacy of preservice elementary teachers. *Journal of Research in Science Teaching*, 21 (1), 39-46.
- Beall, D. & Harty, H. (1984, Summer). Inservice teachers' reactions to implementing microcomputers in elementary science and mathematics classes. *Journal of Computers in Math and Science Teaching*, 34-38.
- Bernier, M. & Poser, E. G. (1984). The relationship between self-efficacy, attributions, and weight loss in a weight rehabilitation program. *Rehabilitation Psychology*, 29, 95-105.
- Biran, M. & Wilson, G. T. (1981) . Cognitive versus behavioral methods in the treatment of phobic disorders: A self-efficacy analysis. *Journal of Consulting and Clinical Psychology*, 49, 886-899.
- Borg, W. R. & Gall, M. D. (1983). *Educational Research*. New York: Longman.
- Brice, D.J. & Sassenrath, J.M. (1978) . Effects of locus of control, task instructions, and belief on expectancy of success. *The Journal of Social Psychology*, 104, 97-105.
- Brod, M. I. & Hall, S. M. (1984). Joiners and non-joiners in smoking treatment: A comparison of psychosocial variables. *Addictive Behaviors*, 9, 217-221.
- Campbell, D. T. & Stanley, J. C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Boston: Houghton Mifflin.
- Carey, D. M. (1986). An investigation of factors that affect elementary school teachers' educational use of computers (Doctoral dissertation, University of Oregon, 1985). *Dissertation Abstracts International*, 46, 3233A.
- Chambliss, C.A. & Murray, E.J. (1979a) . Cognitive procedures for smoking reduction: symptom attribution versus efficacy attribution. *Cognitive Therapy and Research*, 3, 91-95.
- Chambliss, C.A. & Murray, E.J. (1979b) . Efficacy attribution, locus of control and weight loss. *Cognitive Therapy and Research*, 4, 349-353.
- Chapin, M. & Dyck, D. G. (1976) . Persistence in children's reading behavior as a function of N length and attribution retraining. *Journal of Abnormal Psychology*, 85, 511-515.
- Clark, R.E. (1983) . Reconsidering research on learning from media. *Review of Educational Research*, 53, 445-460.
- Clark, R.E. (1985a) . Confounding in educational computing research. *Journal of Educational Computing Research*, 1, 137-148.
- Clark, R.E. (1985b) . The importance of treatment explication: A reply to J. Kulik, C.L. Kulik and R. Bangert-Drowns. *Journal of Educational Computing Research*, 1, 389-394.
- Clark, R.E. & Salomon, G. (1986) . Media in teaching. In M. C. Wittrock (Ed.), *Handbook on Research on Teaching* (pp. 464 - 478). New York: MacMillan.
- Coelho, R. J. (1984). Self-efficacy and cessation of smoking. *Psychological Reports*, 54, 309-310.
- Coovert, M. D. & Goldstein, M. (1980) . Locus of control as a predictor of users attitude toward computers. *Psychological Reports*, 47, 1167-1173.
- Courtney, E. W. (1984). *Analysis*. Corvallis, Oregon: Division of Continuing Education, Oregon State University.

- Cronbach, L.J. & Snow, R.E. (1977) . *Aptitudes and Instructional Methods*. New York: Irvington Publishers.
- Daniels, R. & Stevens, J. (1976). The integration between the internal-external locus of control and two methods of college instruction. *American Educational Research Journal*, 2, 103-113.
- Deci, E. (1975). *Intrinsic Motivation*. New York: Plenum Press.
- DeVault, M.V. & Chapin, J.D. (1981) . The teacher factor in the supply and demand curve for technology in the schools. *Educational Technology*, 11 (2), 7-14.
- Dickerson, L. & Pritchard, W., Jr. (1981) . Microcomputers and education: Planning for the coming revolution in the classroom. *Educational Technology*, 21, 7-12.
- Duke, M. P. & Nowicki, S. (1974). Locus of control and achievement - The confirmation of a theoretical expectation. *Journal of Psychology*, 87, 263-267.
- Elkins, R. (1985) . Attitudes of special education personnel toward computers. *Educational Technology*, 15 (7), 31-34.
- Feltz, D. L., Landers, D. M., & Raeder, U. (1979). Enhancing self-efficacy in high-avoidance motor tasks: A comparison of modeling techniques. *Journal of Sport Psychology*, 1, 112-122.
- Ferguson, G. A. (1976). *Statistical Analysis in Psychology and Education* (4th ed.). New York: McGraw-Hill.
- Goldfried, M. R. & Robins, C. (1982). On the facilitation of self-efficacy. *Cognitive Therapy and Research*, 6, 361-380.
- Harter, S. (1978). Effectance motivation reconsidered: Toward a developmental model. *Human Development*, 21, 34-64.
- Hill, R. (1978) . Internality: an educational imperative. *Journal of Humanistic Psychology*, 18, 43-49.
- Horak, V. & Horak, W.J. (1982) . The influence of student locus of control and learning method on mathematics achievement. *Journal of Experimental Education*, 51, 18-21.
- Horak, W. J. & Slobodzian, K. A. (1980) . Influence of instructional structure and locus of control on achievement of preservice elementary science teachers. *Journal of Research in Science Teaching*, 7, 213-222.
- The leading edge. *TechTrends*, 1985, 30 (7), 4.
- Lee, C. (1984a). Reactivity of measures of self-efficacy in tasks involving Lee, C. (1984a). Reactivity of measures of self-efficacy in tasks involving assertiveness. *Behavioral Psychotherapy*, 12, 46-60.
- Lee, C. (1984b). Accuracy of efficacy and outcome expectations in predicting performance in a simulated assertiveness task. *Cognitive Therapy and Research*, 8, 37-48.
- Lefcourt, H. M. (1976). *Locus of Control: Current trends in theory and research*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Lefcourt, H. M. (Ed.). (1981-1984). *Research with the Locus of Control Construct* Vols. 1-3). New York: Academic Press.

- Lent, R. W., Brown, S. D., & Larkin, K.C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology*, 31, 356-362.
- Leone, C., Minor, S. W., & Baltimore, M. (1983). A comparison of cognitive and performance-based treatment analogues: Constrained thought versus performance accomplishments. *Cognitive Therapy and Research*, 7, 445-454.
- Lorber, M.A. (1984). Computers cause (and help solve) curricular problems - and extend the mind. *Electronic Learning*, 4 (2), 17-20.
- Loyd, B. H. & Gressard, C. (1984). Reliability and factorial validity of computer attitude scales. *Educational and Psychological Measurement*, 44, 501-505.
- Miller, W. R. (1983). Motivational interviewing with problem drinkers. *Behavioral Psychotherapy*, 11, 147-172.
- Minor, S.W. & Roberts, A.M. (1984). Effects of congruence between locus of control and task instructions on self-efficacy. *Psychological Reports*, 54, 39-42.
- Mitchell, C. & Stuart, R. B. (1984). Effect of self-efficacy on dropout from obesity treatment. *Journal of Consulting and Clinical Psychology*, 52, 1100-1101.
- Moskowitz, J.H. & Birman, B.F. (1985). Computers in the schools: implications of change. *Educational Technology*, 15 (1), 7-14.
- Moursund, D. (1983a). District inservice planning. *The Computing Teacher*, 10 (7), 3-4.
- Moursund, D. (1983b). Greener grass. *The Computing Teacher*, 11 (2), 3-4.
- Moursund, D. (1986). Logo revisited. *The Computing Teacher*, 13 (6), 4-5.
- Nelson, P. & Waack, W. (1985). The status of computer literacy/computer-assisted instruction awareness as a factor in classroom instruction and teacher selection. *Educational Technology*, 15 (10), 23-26.
- Nicki, R. M., Remington, R. E., & MacDonald, G. A. (1984). Self-efficacy, nicotine-fading/self-monitoring and cigarette-smoking behavior. *Behavioral Research and Therapy*, 22, 477-485.
- Parent, J., Forward, J., Canter, R. & Mohling, J. (1975). Interactive effects of teaching strategy and personal locus of control on student performance and satisfaction. *Journal of Educational Psychology*, 67, 764-769.
- Pines, H. A. (1973). An attributional analysis of locus of control orientation and source of informational dependence. *Journal of Personality and Social Psychology*, 23, 262-267.
- Pines, H. A. & Julian, J. W. (1972). Effects of task and social demands on locus of control differences in information processing. *Journal of Personality*, 40, 407-416.
- Rotter, J.B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs*, 80 (609).
- Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology*, 73, 93-105.
- Schunk, D. H. (1982). Effects of effort attributional feedback on children's perceived self-efficacy and achievement. *Journal of Educational Psychology*, 74, 548-556.

- Schunk, D. H. (1983a). Reward contingencies and the development of children's skills and self-efficacy. *Journal of Educational Psychology*, 75, 511-518.
- Schunk, D. H. (1983b). Ability versus effort attributional feedback: Differential effects on self-efficacy and achievement. *Journal of Educational Psychology*, 75, 848-856.
- Schunk, D. H. (1984). Enhancing self-efficacy and achievement through rewards and goals: Motivational and informational effects. *Journal of Educational Research*, 78, 29-34.
- Sherwood, R.D., Connor, J.V., & Goldberg, K.P. (1981) . Developing computer literacy and competency for preservice and inservice teachers. *The Journal of Computers in Mathematics and Science Teaching*, 1, 23-24.
- Shiffman, S. (1984). Cognitive antecedents and sequelae of smoking relapse crises. *Journal of Applied Social Psychology*, 14, 296-309.
- Stake, J. (1979). The relationship between achievement orientation and locus of control. *The Journal of Social Psychology*, 109, 149-150.
- Stipek, D.J. & Weisz, J.R. (1981) . Perceived control and academic achievement. *Review of Educational Research*, 51, 101-137.
- Tatsuoka, M. M. (1971). *Multivariate Analysis: Techniques for Educational and Psychological Research*. New York: John Wiley & Sons.
- Walden, T.A. & Ramey, C.T. (1983) . Locus of control and academic achievement. *Journal of Educational Psychology*, 75, 347-351.
- Weinberg, R. et al. (1984). Effects of preexisting and manipulated self-efficacy on weight loss in a self-control program. *Journal of Research in Personality*, 18, 353-358.
- Weiner, B. (1972). *Theories of Motivation: From mechanism to cognition*. Chicago: Markham Publishing.
- Weiner, B. (Ed.). (1974). *Achievement Motivation and Attribution Theory*. Morristown, New Jersey: General Learning Press.
- Weiner, B. (1977). An attributional approach for educational psychology. In L. Shulman (Ed.), *Review of Research in Education* (Vol. 4). New York: Plenum.
- Wesley, B.E., Krockover, G.H., & Hicks, C.R. (1985) . Locus of control and acquisition of computer literacy. *Journal of Computer-Based Instruction*, 12 (1), 12-16.
- White, R. (1959). Motivation reconsidered. The concept of competence. *Psychological Review*, 66, 297-323.
- Wright, E. B. & Forcier, R. C. (1985). *The Computer: A Tool for the Teacher*. Belmont, California: Wadsworth.

APPENDICES

Appendix A

Locus of Control Scale and Questionnaire

STUDENT QUESTIONNAIRE

The following questionnaire is part of a research study. It consists of two sections: 1) a general survey of your attitudes and opinions; and 2) general information about your background and experiences with computers. You are to complete both sections during this class period.

The findings from this study will provide valuable information to education departments in evaluating their curricula. There are no right or wrong answers to these questions. **Your responses will be kept confidential and will in no way affect your grade.** To ensure this, you may chose to use a code name instead of your real name if you like. Just make sure that you remember your code name so we can match data later on in the term. The preliminary results of this study will be available at the end of the term.

Please take the time to fill out all sections of this questionnaire accurately. Use the answer sheet that is provided and a #2 pencil to record your answers. On the Scantron answer sheet, fill in your name (or code name) in the "name" space, and the course number (ED. 361 or ED. 435) in the "subject" space.

Your cooperation and careful answers to these questions are greatly appreciated.

If you have any questions, ask the administrator of this questionnaire.

PART 1

Each item below consists of two statements (a and b). Read the statements quickly; then mark either "a" or "b" on your answer sheet depending on which statement is the truest for you. If you don't agree with either of the statements, mark the one that you agree with the most. Please mark an answer for each question.

1. a. Children get into trouble because their parents punish them too much.
 b. The trouble with most children nowadays is that their parents are too easy with them.
2. a. Many of the unhappy things in peoples' lives are partly due to bad luck.
 b. Peoples' misfortunes result from the mistakes they make.
3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.
 b. There will always be wars no matter how hard people try to prevent them.
4. a. In the long run people get the respect they deserve in this world.
 b. Unfortunately, an individual's worth often passes unrecognized no matter how much effort is made.
5. a. The idea that teachers are unfair to students is nonsense.
 b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6.
 - a. Without the right breaks one cannot be an effective leader.
 - b. Capable people who fail to become leaders have not taken advantage of their opportunities.
7.
 - a. No matter how hard you try, some people just don't like you.
 - b. People who can't get others to like them, don't understand how to get along with others.
8.
 - a. Heredity plays a major role in determining one's personality.
 - b. It is peoples' experiences in life which determine what they are like.
9.
 - a. I have often found that what is going to happen, will happen.
 - b. Trusting to fate has never turned out as well for me as taking a definite course of action.
10.
 - a. In the case of a well prepared student, there is rarely, if ever, such a thing as an unfair test.
 - b. Many times exam questions tend to be so unrelated to course work that studying is really useless.
11.
 - a. Becoming a success is a matter of hard work; luck has little or nothing to do with it.
 - b. Getting a good job depends mainly on being in the right place at the right time.
12.
 - a. The average citizen can have an influence in government decisions.
 - b. This world is run by the few people in power, and there is not much the little person can do about it.
13.
 - a. When I make plans, I am almost certain that I can make them work.
 - b. It is not always wise to plan too far ahead because many times things turn out to be a matter of good or bad fortune anyhow.

14. a. There are certain people who are no good.
b. There is some good in everybody.
15. a. In my case, getting what I want has little or nothing to do with luck.
b. Many times we might just as well decided what to do by flipping a coin.
16. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
b. Getting people to do the right thing depends on ability. Luck has little or nothing to do with it.
17. a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand nor control.
b. By taking an active part in political and social affairs, people can control world events.
18. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.
b. There really is no such thing as "luck".
19. a. One should always be willing to admit mistakes.
b. It is usually best to cover up one's mistakes.
20. a. It is hard to know whether or not a person really likes you.
b. How many friends you have depends on how nice a person you are.

- 21.
 - a. In the long run, the bad things that happen to us are balanced by the good ones.
 - b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

- 22.
 - a. With enough effort we can wipe out political corruption.
 - b. It is difficult for people to have much control over the things politicians do in office.

- 23.
 - a. Sometimes I can't understand how teachers arrive at the grades they give.
 - b. There is a direct connection between how hard I study and the grades I get.

- 24.
 - a. A good leader expects people to decide for themselves what they should do.
 - b. A good leader makes it clear to everyone what their jobs are.

- 25.
 - a. Many times I feel that I have little influence over the things that happen to me.
 - b. It is impossible for me to believe that chance or luck plays an important role in my life.

- 26.
 - a. People are lonely because they don't try to be friendly.
 - b. There is not much use in trying too hard to please people. If they like you, they like you.

- 27.
 - a. There is too much emphasis on athletics in high school.
 - b. Team sports are an excellent way to build character.

- 28.
 - a. What happens to me is my own doing.
 - b. Sometimes I feel that I don't have enough control over the direction my life is taking.

29. a. Most of the time I can't understand why politicians behave the way they do.
- b. In the long run, the people are responsible for bad government on a national, as well as on a local level.

PART 2

Please mark the statement which describes you the best.

30. Your age:

[a] 18 or less [b] 19 or 20 [c] 21-24 [d] 25-30 [e] over 30

31. Your class in college:

[a] Freshman [b] Sophomore [c] Junior [d] Senior [e] Graduate

32. How many courses in Computer Literacy and Applications have you completed ? (e.g. social issues, computer hardware, word processing, etc.)

[a] none [b] 1 [c] 2 [d] 3 [e] more than 3

33. How many courses in computer programming have you completed ?

[a] none [b] 1 [c] 2 [d] 3 [e] more than 3

34. If you have taken a computer programming course, what computer language did you learn ? (mark all that apply)

[a] BASIC [b] Logo [c] Pascal [d] PILOT [e] Other

35. How many courses in computer applications in education have you completed?

- [a] none [b] 1 [c] 2 [d] 3 [e] more than 3

36. Do you plan to enroll in any courses in computer applications in education in the future?

- [a] definitely no [b] probably no [c] maybe [d] probably yes [e] definitely yes

37. During the last 4 months, how many hours (approximately) have you used a computer for word processing?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

38. During the last 4 months, how many hours (approximately) have you used a computer for programming?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

39. During the last 4 months, how many hours (approximately) have you used a computer for working with a spreadsheet?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

40. During the last 4 months, how many hours (approximately) have you used a computer for data bases or filers?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

41. During the last 4 months, how many hours (approximately) have you used a computer for electronic mail or messages?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

42. During the last 4 months, how many hours (approximately) have you used a computer for video games on a microcomputer?

- [a] none [b] 1-4 hrs. [c] 5-12 hrs. [d] 13- 24 hrs. [e] more than 24

Appendix B
MCLAA Affective Scales

COMPUTER QUESTIONNAIRE

DIRECTIONS: On the Scantron answer sheet, fill in your name (or code name from the beginning of the term) in the "name" space, and the course number (ED. 361 or ED. 435) in the "subject" space.

Indicate how much you AGREE or DISAGREE with each of the following statements by marking the appropriate letter on the answer sheet. Mark "a" if you STRONGLY DISAGREE with the statement. Mark "b" if you DISAGREE with the statement a little. Mark "c" if you are UNDECIDED about whether you agree or disagree with the statement. Mark "d" if you AGREE with the statement a little. Mark "e" if you STRONGLY AGREE with the statement.

As an example, if you AGREE a little that computers are noisy, then mark "d" on the answer sheet as shown below:

Computers are noisy. [a] [b] [c] [d] [e]

Or if you are UNDECIDED about whether computers are noisy, mark "c" on the answer sheet as shown below:

Computers are noisy. [a] [b] [c] [d] [e]

If you have any questions, ask the test administrator.

PLEASE MARK YOUR
ANSWERS ON THE
ANSWER SHEET.

	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE
1. I would like to learn more about computers.	a	b	c	d	e
2. Working with a computer would probably make me feel uneasy or tense.	a	b	c	d	e
3. I feel helpless around a computer.	a	b	c	d	e
4. Computers sometimes scare me.	a	b	c	d	e
5. I would very much like to have my own computer.	a	b	c	d	e
6. I like the idea of taking computer courses.	a	b	c	d	e
7. I enjoy (or think I would enjoy) using computers in my classes.	a	b	c	d	e
8. Walking through a room filled with computers would make me feel uneasy.	a	b	c	d	e

PLEASE MARK YOUR
ANSWERS ON THE
ANSWER SHEET.

STRONGLY DISAGREE

DISAGREE

UNDECIDED

AGREE

STRONGLY AGREE

- | | | | | | |
|---|---|---|---|---|---|
| 9. I feel uneasy when I am with people who are talking about computers. | a | b | c | d | e |
| 10. I enjoy (or think I would enjoy) working with computers. | a | b | c | d | e |
| 11. I feel confident about my ability to use computers. | a | b | c | d | e |
| 12. It is my guess that I am <u>not</u> the kind of person who works well with computers. | a | b | c | d | e |
| 13. On the whole, I can cope with computers in my daily living. | a | b | c | d | e |
| 14. I am able to work with computers as well as most others my age. | a | b | c | d | e |
| 15. Computers are gaining too much control over my life. | a | b | c | d | e |

PLEASE MARK YOUR
ANSWERS ON THE
ANSWER SHEET.

STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

- | | | | | | |
|--|---|---|---|---|---|
| 16. Every secondary school student should know something about computers. | a | b | c | d | e |
| 17. Every secondary school student should be able to write a simple computer program. | a | b | c | d | e |
| 18. Every secondary school student should learn about the role that computers play in our society. | a | b | c | d | e |
| 19. Computers can be useful in learning many subjects besides mathematics. | a | b | c | d | e |
| 20. Computers are of little use in education. | a | b | c | d | e |
| 21. I plan to enroll in a course in computer applications in education in the future. | a | b | c | d | e |

Appendix C

Explorations in Logo

Central to the learning theory of the Swiss psychologist Jean Piaget is the idea that children learn without being taught. Long before they enter school they have mastered the complexities of language and speech enough to understand and communicate with those around them. They have gained an intuitive sense of body geometry that enables them to get around in space, and they have learned enough logic and rhetoric to convey their desires to parents and peers. Children learn all these things effectively without formal teachers and curriculum, and without explicit rewards and punishments. They learn by simply interacting with their environment, relating what is new and to be learned to what they know from past experience.

For example, a very young child can build a cognitive structure or a concept of "dogness": Dogs look, feel, sound and smell a certain way. Whenever a dog is encountered, the child attempts to make sense of the experience by calling on a previously formed cognitive structure of "dog". Piaget called this process *assimilation*. But a new dog may be different from the one met before. As new elements are encountered (a curly tail instead of a straight one, long, shaggy hair instead of short hair, and so on), the cognitive structure for "dog" must be modified and enlarged to encompass the new information, a process Piaget called *accomodation*.

Let us think of children in Piagetian terms, as the active builders of their own cognitive structures, and consider the kinds of experiences and materials our culture provides for use in this building process. Children have many experiences that help in forming an intuitive sense of number and quantity. They pass out candies to their friends, and set places at the dinner table; many things in a child's life come in pairs (socks and shoes, salt and pepper). Our culture is rich not only in experiences involving these concepts, but rich in the language to talk about them as well. Thus children are provided with the tools and materials and the incentives to explore and think about these issues. Indeed, Seymour Papert suggests that in the computer-rich culture of the not-too-distant future, we will have the opportunity to create new environments or "microworlds", where new

materials and models will be available for children and adults to use in building and expanding their intellectual frameworks.

Papert, who was trained as a mathematician, became concerned with what he calls "mathphobia," or the aversion to mathematics. You often hear people say "I'm just not math-minded," or "I never did have a head for figures." Papert feels that this attitude often generalizes into a fear of learning itself. After studying with Piaget in Geneva for about 5 years, Papert came back to M.I.T. and set out to create a mathematically rich environment where children could explore and experiment with mathematical concepts in a creative way, where they would learn by doing and thinking about what they did. He wanted to create a "Mathland" where people could learn the "language" of mathematics in the same way that they learn the language of a particular country by living there.

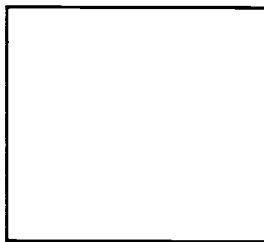
Logo is the name assigned to the research group at M.I.T. headed by Papert, and it is the name of the computer programming language that was the result of that group's work. But more than that, Logo is an educational philosophy based on Piaget's learning theory and on ideas from the field of artificial intelligence. Logo was intended to be learned, but not taught. It is learned through a process of active, creative exploration, and in the process, the child must think about thinking and learn about learning.

With Logo, knowledge that was formerly accessible only through abstract, formal thinking can be approached concretely with "an object to think with" that Papert calls the **turtle**. This computer-controlled, cybernetic animal exists in the Logo environment. There are floor turtles (physical objects that can be picked up like any mechanical toy), and there are screen turtles, which reside on the computer monitor screen. Both have the ability to draw lines as they move. We communicate with the turtle and tell it what to do by speaking "turtle talk", the Logo computer language.

For young children, one power of Logo is that they can identify the movements of their own bodies with those of the turtle. To take advantage of this power, we start by having the children "play turtle." After introducing some basic turtle-talk commands such as **FORWARD**, **BACK**, **RIGHT** and **LEFT**, we provide many opportunities for children to walk out shapes and describe their actions

in turtle talk. They practice by directing each other around the room or playground with turtle commands. In the process, they are taking the first step toward thinking about their thinking, because they must reflect on how they would do themselves what they would like the turtle to do. In addition, they are gaining a personal, visual and kinesthetic sense of basic geometric principles.

After these concrete experiences, the transition to the screen turtle is relatively easy. Let's say the child has had the physical experience of walking and turtle-talking this shape: (I encourage you to try playing turtle - it's FUN!)



The turtle talk might sound like this : I go forward some, then I turn right. I go forward the same distance and right again. Then I go forward again and then right, and forward and right, so I end up exactly where I started. If you tried playing turtle yourself, you may have found that it was harder than you thought it would be at first. These activities are important to help children start seeing how larger activities are broken into smaller, discrete steps.

Now we will embark on the project of getting the screen turtle to draw this same shape. First, you must load the Logo language into your computer. Insert the Logo language disk into the disk drive, face up with the label out. Close the little door on the disk drive and turn on the computer and monitor (if you need help with this part, the lab assistant will be happy to help.) In a few moments, the disk drive will turn off and you will get a "Welcome to Logo" message.

The remainder of this lesson will be delivered via the audio cassette tape, so you should insert the tape and begin this part now.

Appendix D

Description of Computer Program for Program-controlled Module

The computer program for the program-controlled module was written in the Logo language. The program is intended to be used with the accompanying audio tape which provides a narration and explanation of what is seen on the screen.

The program is divided into three sections. Each section introduces and demonstrates beginning concepts of the Logo language. The first two sections are followed by a set of review questions which apply the concepts just learned. A summary of the concepts introduced in each section, and the question set for each, follows.

Section 1

Concepts:

Properties of the Turtle: position, heading, HOME position;

Changing position: FORWARD, BACK;

Changing heading: RIGHT, LEFT;

Using negative numbers;

The Total Turtle Trip: drawing a square;

Seeking patterns: REPEAT.

Question Set:

- 1) Which command would move the Turtle the greatest distance?
 - a) REPEAT 10 [FD 5]
 - b) REPEAT 5 [FD 10]
 - c) FD 100
- 2) From the HOME position, which command would turn the Turtle facing directly down towards the bottom of the screen?
 - a) RT 100
 - b) RT 180
 - c) REPEAT 4 [RT 90]
- 3) When you see the message "FORWARD NEEDS MORE INPUTS" on the screen, it means
 - a) The Turtle will be hidden if it goes forward any more.
 - b) You have to type SHOWTURTLE before you tell it to go FORWARD.
 - c) You haven't told the Turtle how many turtle steps to take.

4) Which two of the following commands will move the Turtle the same distance in the same direction?

- a) FD 100
- b) REPEAT 4 [FD 25]
- c) BK -100

Section 2

Concepts:

Writing procedures: TO BOX;

Using procedures with direct commands;

Moving the Turtle without drawing: PENUP, PENDOWN.

Question Set:

5) If the command REPEAT 4 [FD 50 RT 90] makes a square, which of the following commands would make a triangle?

- a) REPEAT 3 [FD 50 RT 120]
- b) REPEAT 120 [FD 50 RT 3]
- c) REPEAT 50 [FD 3 RT 120]

6) The command that would let Logo know that you want to define a new procedure called RECTANGLE would be

- a) RECTANGLE
- b) TO RECTANGLE
- c) DRAW RECTANGLE

7) Which of the following command lines would draw a rectangle?

- a) FD 50 RT 90 FD 10 RT 90 FD 50 RT 90 FD 10 RT 90
- b) REPEAT 2 [FD 50 RT 90 FD 10 RT 90]
- c) Both would draw a rectangle.

8) What shape will the following command line make: REPEAT 360 [FD 1 RT 1] ?

- a) a dot
- b) a circle
- c) a 360-sided polygon

9) What will you see on the screen if you command the Turtle to
PU RT 45 FD 50 PD ?

- a) a horizontal line
- b) a vertical line
- c) a diagonal line
- d) none of these

Section 3

Concepts:

Subprocedures: defining objects in terms of other objects;

Debugging;

Process versus Product;

Other Logo microworlds: music, words;

Uses of Logo.

(No question set for this section.)

Appendix E

Transcript of Audio Tape for Program-controlled Module

When I count to three, press the RETURN key. 1...2...3.

Since we want to start by working with the Turtle, we need to type the word `showturtle`. The screen Turtle is the triangular shaped object you see on the screen. It has two properties: position, or where it is on the screen (right in the middle now), and heading, or which direction it is pointing (straight up now. This is called the Turtle's HOME position.

Now we can get the Turtle to draw the shape we turtle-talked before. It looked like a square. You remember from playing Turtle that the first thing you did was go FORWARD some distance. So we will type in the word FORWARD. The error message "forward needs more inputs" is Logo's way of complaining that we did not tell the Turtle how far forward we want him to go! The Logo commands FORWARD AND BACK need an input, a number indicating how many turtle-steps to take.

When people first experiment with moving the Turtle, they have no idea how big turtle-steps are, and they will often type in something like `FD 5`. As you can see, the Turtle takes very tiny steps. So let's try a larger number - say 50. We'll command the Turtle to go `FD 50`. Now we're getting a better idea of how the Turtle moves. Let's try `FD 150`. OOPs - where'd the Turtle go? Was 150 too big? No, the Turtle is still there, but it's hiding behind the 4 lines of text at the bottom of the screen. By typing the word `FULLSCREEN` the text lines at the bottom will disappear and we will be able to see the full graphics screen. Now you can see that `FORWARD 150` sent the Turtle off the top of the screen and wrapped it around the bottom.

Let's try the BACK command. First, we'll send the Turtle home and clear the screen. The command `DRAW` does this. Now let's command the Turtle to go `BACK 50`. How about `BACK 50` again. And again. The commands `FD` and `BK` send the Turtle forward or back the specified number of turtle steps from where he is at the moment of the command. So if we tell the Turtle to go back 50 three times in all, the Turtle has actually travelled a total of 150 turtle steps.

The commands FORWARD AND BACK change the Turtle's position, or where it is on the screen. How about changing its heading, or the direction it is facing. The commands RIGHT AND LEFT will do that. When we type in the word RIGHT, we get that same message again - RIGHT NEEDS MORE INPUTS. We haven't told the Turtle how far we want him to turn. So let's try RIGHT 90. You can see that RIGHT 90 turns the Turtle clockwise 90 degrees. If we now enter the command RIGHT 180, the Turtle will continue clockwise from where it was, another 180 degrees. Let's try LEFT. If we tell the Turtle to go left 30 three times, it will turn counterclockwise a total of 90 degrees.

Since the Logo turtle is a mathematics speaking animal, it also recognizes and understands negative numbers. Watch what happens when we command the turtle to go forward -50. Hmm... the turtle goes backwards! How about right -90. The turtle turned left 90.

A negative number is called the opposite or inverse of a positive number. So the opposite of going forward 50 is going back 50 and the opposite or inverse of going right 90 is left 90. In the Logo environment, children have the opportunity to playfully explore many such otherwise abstract concepts.

Now that we have a better idea of how the Turtle moves and turns, we can get it to draw the square. Let's start by giving the Turtle a FD 50 command. Next, we need a 90 degree turn - RIGHT 90. Our Turtle has now completed one side and one turn for our square. So now, in order to complete our shape, we will need to command the Turtle to make three more sides and turns. FD 50, RT 90, FD 50, RT 90, FD 50 and one more RT 90 so that the Turtle has taken the Total Turtle Trip - it has ended in the exact place it started - facing the same direction.

A new command that we introduce to children fairly early on is REPEAT. When we use REPEAT we look for patterns in our directions to the Turtle. Look at the commands on the screen starting with the first forward. You will notice that we seemed to do the same set of things (fd 50 RT 90) over and over again to draw the square. How many times is that set of instructions repeated? We went FD 50 RT 90 four times in all. By introducing the REPEAT command we are encouraging children to start to organize their thinking and are also introducing the powerful idea of looking for

patterns as a valuable problem solving technique. We can use the REPEAT command to simplify the directions to the Turtle. Notice the abbreviations for FORWARD, FD, AND RIGHT, RT. This saves on typing and they are easy to remember as they are the beginning and ending sounds of the words. The command REPEAT 4 [FD 50 RT 90] tells the Turtle to do the set of things inside the brackets [FD 50 RT 90] four times in all.

Now let's review what you've learned so far. Pause the tape when I count to three, then press RETURN and work through the next part of the lesson on the computer.

Press the RETURN key when I count to three. 1...2...3.

So far we have been working in the direct mode - we typed in commands for the square and the Turtle did it. Now we want to teach the Turtle how to draw that shape once and for all. We are going to write a Logo procedure (a computer program that the Turtle will remember just as he remembers the commands FD, BK, RT, LT. With children we say we are teaching the Turtle a new word. We will define a new word for the Turtle to put in his dictionary along with FD, BK, RT AND LT. Now we all know that our shape is called a square. But a very young child may not know that and in Logo it doesn't matter. She can call it anything she wants. Maybe to her it looks like a box and she would like to teach her Turtle how TO BOX. The command TO, T-O, lets Logo know that you are about to write a new procedure and prepares the screen for you to do this. When we type in TO BOX, the turtle will disappear and we will see the words TO BOX at the top of the screen. The TO command signifies that this is a procedure definition and it is followed by the name we have chosen to call that procedure (BOX in this case. WE are now ready to type in the commands the Turtle will need to follow in order to draw the BOX. REPEAT 4 [FD 50 RT 90].

After we have defined the word BOX we are ready to try it. When we type in the word BOX, the Turtle understands that word and follows the directions we gave it to draw the shape. BOX is now a Logo procedure and we can use it just like any other Logo command. We can tell it to BOX, then go RT 45 and then BOX again. We can combine the BOX and RT commands and use REPEAT to get an even more complex design. Many shapes that look really hard at first are actually pretty easy with

Logo. It doesn't take long for even the youngest Logo student to get some very interesting things on the screen.

If we want the Turtle to move without drawing a line, we can command the Turtle to pick it's pen up with the word `PENUP`. Then when we tell the Turtle to go `RT 90` and `FD 35` and then `LT 90`, the Turtle will not leave a trail. The command `PENDOWN` puts the pen down again to start drawing. Let's try a row of four boxes. Repeat this set of things four times - draw a box, then move over by picking the pen up, turning right 90 degrees, go forward 35, turn left 90, then put the pen down. `REPEAT 4 [BOX PU RT 90 FD 35 LT 90 PD]`.

Let's review this part of the lesson. Pause the tape and work through the next activities on the computer.

Press `RETURN` on the count of three. 1...2...3.

Let's say our young Logo student has defined the procedure `TO BOX`. She then teaches the Turtle how `TO POINT`. Her procedure is what you see on the screen. When she tells the Turtle to `POINT`, this is what she sees. Our young Logo student plays with `POINT` for awhile. She tries spinning it around - `REPEAT 36 [POINT LT 10]` She makes a tower of `POINTS` - `REPEAT 3 [POINT PU FD 30 PD]` She tries this command and gets this design `REPEAT 3 [POINT RT 120]`

Next, our student decides she would really like to draw a house. She draws a sketch, which might look like what you see on the screen now. Our student could begin to define the house procedure by combining `FDS`, `BKS`, `LTS` AND `RTS`. But when she looks closely at her sketch she realizes that the Turtle already knows how to draw something that looks like the base of the house, her familiar `BOX` procedure, and the Turtle also knows how to draw the roof shape- it looks like her point. Maybe she can put those two procedures together to get her house. By defining one object in terms of other simpler objects, the child is encouraged to think procedurally, to derive one concept from another and in so doing discover the relatedness between concepts. She can break the house problem down into what Seymour Papert calls "mind-sized bites" and use these procedures to define her house. `TO HOUSE - BOX and then POINT`.

When we try the house procedure by typing HOUSE, this is what we get. Your first reaction to this might be "That's all wrong! Erase it, try again." No - In the ocomputer world things hardly ever work out right the first time. Sure, its not exactly what we expected, but it really is kind of neat. We may want to save this design to use later in another drawing. The question is not "is it right or wrong?" but "is it fixable?" Thanks to the computer culture, we now even have a word for this - debugging. This is a very powerful idea and one that is not commonly found in schools today. The children's answers are usually judged with right/wrong, black/white types of logic. In real life, there are many shades of gray. Take another look at our house. There really is more that is right about it than wrong. It is exactly the shape we want only it's lying on its side. We can fix it by making a turn to the right 90 degrees. We'll write a new procedure to solve this problem. We'll call it NEWHOUSE.

The NEWHOUSE procedure consists of a RIGHT 90 and then HOUSE. We can use any previously defined procedures as part of new procedure definitions. NEWHOUSE uses the subprocedure HOUSE, which uses the subprocedures BOX AND POINT. The ability of Logo to do this is one thing that sets it apart from other computer langauges such as BASIC. Now lets try NEWHOUSE. VOILA! We fixed it!

Pause the tape now and work through the next computer exercises.

In this short introduction to Logo, you have probably made some important discoveries about the Turtle and how it moves, about problem-solving and thinking about thinking. The processes you have gotten in touch with are much more important than any product or picture we got on the screen. When children interact in the Logo environment, playing, experimenting, debugging, they learn what the Turtle can do by forming a hypothesis, trying it out, noticing what happens and debugging, or rethinking their strategies. This is learning in the true Piagetian sense.

We have been working in the Logo microworld of Turtle graphics, but Logo is much more than this. We can write Logo procedures to play music, control robots, process numbers and manipulate words as well. In fact, the lesson you have just worked through was written in the Logo language. Although Logo is simple enough for three and four year-olds to learn, it is also open-ended at the top

level, capable of performing sophisticated functions found in other languages such as BASIC or PASCAL. People who have a background in other languages sometimes feel that Logo is "a baby language for kids." They soon come to realize that it is a very high-level computer-programming language incorporating powerful ideas from the fields of mathematics, science and artificial intelligence. Many come to appreciate it for its sophisticated simplicity. Mathematicians can use Logo to manipulate vectors, graph equations and explore non-flat geometries. Physicists can experiment with Newtonian laws of motion by giving the Turtle the property of velocity. Teachers can create simulations, write Drill and Practice programs or invent interactive games for their students using the Logo language. In this short introduction we have barely scratched the surface of the possibilities. We encourage you to experiment more with Logo and discover its capabilities.

This ends our Explorations in Logo session for today. Please turn off the computer and the monitor, remove the disk from the disk drive and rewind the tape to the end. Then return the module to the LARC Assistant.

Appendix F

Transcript of Audio Tape for Student-controlled Module

To begin working with the Logo Turtle, you will need to have the Logo language loaded into the working memory of your computer. Insert the Logo language disk into the disk drive and turn on your computer. In a few moments you will get a "Welcome to Logo" message. Pause the tape and do this now.

Remember, one of the basic ideas underlying Logo is discovery learning. Logo was never intended to be taught! In this module you will be given many opportunities to turn off the tape and explore the commands. Please make sure you take the time to do this. As you listen to the tape you will use the set of cards included in this packet. They will show you what to type or what you should see on the screen. There is also a Logo Turtle Talk Reference sheet included in this packet which will remind you of all the commands we use in this lesson and give you examples of how they are used. Refer to it if you have problems. Also, you may stop and rewind the tape to go over something if necessary. Learning any new skill takes some amount of time, even if it is relatively simple. So please take the time you need in order to make your own discoveries about the world of the Turtle.

The question mark followed by the blinking cursor indicates that Logo is ready to go and is waiting for you to give it a command. Since we want to start by working with the Turtle, you will need to type `SHOWTURTLE` (all one word) as on card #1. If you make a typing error, the `ESCAPE` key in the upper left-hand corner of the keyboard marked `ESC` will erase the character to the left of the cursor and will move the cursor to that position. These commands are listed on the Turtle Talk Reference Sheet. Pause the tape and type in `SHOWTURTLE` as on card #1.

Now press `RETURN`. The `RETURN` key tells the computer that you are finished typing for now and to take that information and do it. `RETURN` sends the information you have typed to the computer so that it can follow your command.

The screen Turtle is the triangular shaped object you see on the screen. It has two properties: position, or where it is on the screen (right in the middle now), and heading, or which direction it is pointing (straight up now). This is called the Turtle's HOME position.

Now we can get the Turtle to draw the shape we turtle-talked before. It looked like a square. You remember from playing Turtle that the first thing you did was go FORWARD some distance. Pause the tape and type in FORWARD and then press RETURN. Remember, you can use the escape key to correct any typing errors. Pause the tape and refer to card #2.

What you see on the screen is on card #3. The error message "forward needs more inputs" is Logo's way of complaining that we did not tell the Turtle how far forward we want him to go! The Logo commands FORWARD, BACK, RIGHT and LEFT need an input, a number indicating how many turtle-steps to take. In the spirit of Logo, you should experiment with some numbers. Type in any of the commands FORWARD, BACK, RIGHT and LEFT followed by a space and then some number. The space is very important, otherwise Logo will read the line as one word and will complain that it doesn't recognize that command. This is a very common pitfall for people when they first begin in Logo. Remember the space between the command and the number input. When you want to erase what is on the screen and start again, type in DRAW, D-R-A-W, and press RETURN. This will clear the screen and send the Turtle home, to the center facing straight up. Refer to the Logo Turtle Talk Reference sheet if you forget the commands. Pause this tape and play with the Turtle for awhile to get a feeling for how the Turtle moves forwards and backwards and how it turns, and what different number inputs do with those and the right and left commands. Pause the tape.

Did your turtle seem to disappear at times? He really didn't. He was probably hiding behind the text lines at the bottom of the screen. By holding the key marked control down on the left side of the keyboard, while you press F for fullscreen, the text lines at the bottom will disappear and you will see the full graphics screen. Try this now. Hold the control key down and press F. When you want to type commands again, hold the control key and press S for splitscreen and you will see the four lines of text at the bottom of the screen again. Hold the control key down and press S. These commands are also listed on the Logo Turtle Talk Reference sheet.

One of the first discoveries that people often make is that the Turtle takes very tiny steps. So to draw our shape that looked like a square, let's start with the command FORWARD 50. Pause the tape, type in DRAW to clear the screen and then the command as on card #4.

Now when you press RETURN you will see the Turtle move forward 50 turtle steps as on card #5. We will continue drawing our shape by telling the Turtle to go RIGHT. Again, we need to tell the Turtle how far right to turn by inputting a number after the command. If you haven't discovered the relationship between the numbers you use with RIGHT and LEFT and angles, now is your chance to experiment with some different numbers to discover just the right one you need. Remember the space between the command and the input number. Pause the audio tape and experiment with the RIGHT and LEFT commands.

I hope you were able to discover that the number you need with RIGHT to draw a square is 90. Let's start again to draw our shape. Clear the screen by typing DRAW. Then enter the FORWARD 50 and RIGHT 90. I will assume now that you know to press RETURN after each command so that will not appear on the cards any more. Pause the tape and enter the commands as on card #6.

Now your screen should look like what is on card #7 - a line with the Turtle facing right. Each time you give the Turtle a command or series of commands and then press RETURN the Turtle does what you have told him to do. This is called working in the direct mode. Remember to press RETURN to get the Turtle to execute the command.

Our Turtle has now completed one side and one turn for our square. So now, in order to complete our shape, you will need to command the Turtle to make three more sides and turns. If you can't figure out how to do this for yourself, the commands are listed on card #8. Pause the tape and command the Turtle to finish that shape.

Voila! We have our shape! It should look like what is on card #9. If yours doesn't look like that, type in DRAW and try again, following the commands on cards #7 and #8. Take some time now to experiment with the commands FORWARD, BACK, RIGHT and LEFT and see what other shapes you can get the Turtle to draw. Can you get it to draw a triangle or a pentagon? Pause the tape and experiment for awhile.

So far we have been working in the direct mode - you give the Turtle commands, press RETURN and the Turtle does it. Now we want to teach the Turtle how to draw that shape once and for all. We are going to write a Logo procedure (a computer program) that the Turtle will remember just as he remembers the commands FD, BK, RT, LT. With children we say we are teaching the Turtle a new word. We will define a new word for the Turtle to put in his dictionary along with FD, BK, RT and LT. Now we all know that our shape is called a square. But a very young child may not know that and in Logo it doesn't matter. She can call it anything she wants. The only restrictions are that her procedure names begin with a letter and are all one word. Maybe to her it looks like a box and she would like to teach her Turtle how TO BOX. The command TO, T-O, lets Logo know that you are about to write a new procedure and prepares the screen for you to do this. Pause the tape and type in TO BOX as on card #10.

The Turtle will disappear and you will see the words TO BOX at the top of the screen. The TO command signifies that this is a procedure definition and it is followed by the name you have chosen to call that procedure - BOX in this case. You will also see a strip at the bottom of the screen that lets you know you are in the Editing mode. It says, Edit: Control C to define, control G to abort. Holding the control key down while you press C tells Logo you are finished typing the commands for that procedure - your definition is complete. Holding the control key down while you press G tells Logo to Stop. This is the command to use whenever you want to stop whatever is happening in Logo.

When you are in the editing mode, when you see that editing strip at the bottom of the screen, you cannot see the Turtle or any pictures on the graphics screen. You must get out of the editor by typing CTRL C or CTRL G before you can see the Turtle draw again.

Now you are ready to type in the commands the Turtle needs to follow in order to draw the box. Remember when we typed these in before in the direct mode it looked like what you see on card #11. Notice the abbreviations for FORWARD, FD and RIGHT, RT. This saves on typing and they are easy to remember as they are the beginning and ending sounds of the words. What do you think the

abbreviation for BACK would be (pause). BK, beginning and ending sounds. What about LEFT? LT of course.

Enter the commands for BOX just the way they are on card #11. When you have finished typing the commands for that procedure, type control C. This lets Logo know that you are finished and you are ready to define that procedure and exit out of the editor. Pause the tape and do this now.

You should now see on your screen, BOX DEFINED. That means the Turtle will now understand the word BOX just as it understands FD, BK, LT, and RT. Try it by typing the word BOX. Did you see the familiar shape? If not, you may have made a typing error when you were defining the procedure. If it didn't work the way you expected, or if you get an error message of some sort, try again. You will need to erase the definition for the BOX that didn't work by typing ERASE BOX as on card #12. Then type TO BOX and when you get into the editor, retype the commands as on card # 11. Make sure you leave spaces between commands and the number inputs and press RETURN at the end of each line. Remember the escape key to erase typing mistakes. The hold the control key down while you press C to define the procedure.

A new command that we introduce to children fairly early on is REPEAT. When we use REPEAT we look for patterns in our directions to the Turtle. Look at the commands carefully on card #11. You will notice that we seemed to do the same set of things (FD 50 RT 90) over and over again. How many times is that set of instructions repeated? We went FD 50 RT 90 four times in all. By introducing the REPEAT command we are encouraging children to start to organize their thinking and are also introducing the powerful idea of looking for patterns as a valuable problem solving technique. We can use the REPEAT command to simplify the directions to the Turtle in our BOX procedure. Look at the commands shown on card #13. You see the word TO telling the computer you are defining a new procedure and the name I have chosen for this procedure, NEWBOX. You can call yours something else if you like. The directions for NEWBOX tell the Turtle to REPEAT 4 times the set of commands, FD 50 RT 90. On an Apple IIe keyboard there are keys for the square brackets just above the RETURN key. Type in each command as shown on card #13, pressing RETURN at the end of each line. If you make a typing error, remember the escape key at the

far upper-left corner of the keyboard will erase the character to the left of the cursor and will move the cursor to that position. Pause the tape now, and enter the commands as indicated on card #13.

When you have finished typing in the commands for that procedure, remember to type control C to define that procedure and exit the editor. After a few moments you will see NEWBOX DEFINED. Now you are ready to try your new command. Type NEWBOX and you will see the shape again. If not, erase the procedure by typing ERASE NEWBOX and enter it again.

BOX and NEWBOX are now Logo procedures and you can use them just like any other Logo command. The fact that they both draw the exact same shape demonstrates that there is more than one way to solve a problem. One is not more right than the other. They are just different solutions for the same problem.

Now if you type in BOX or NEWBOX again, the Turtle will retrace his steps. Try it, pause the tape. If you turn the Turtle left or right and then type BOX again, you will see a new design. Try RT 45 or some other number, and then BOX as on card #14. Pause the tape.

Try some other designs using your BOX procedure. How about a left turn and then BOX? Or some combination using REPEAT and BOX as on card #15. Pause the tape now and experiment as much as you like with your BOX and NEWBOX procedures, combining them with the other Logo commands that you already know.

You can now use your BOX and NEWBOX procedures as subprocedures to define new words for the Turtle. Try defining a new word for the Turtle as on card #16. Remember, you don't have to call it FOURSQUARE. The beauty of Logo is that you can call it anything you like. The only restrictions are that the name begins with a letter and is all one word. Enter the procedure as on card #16, type control C, then see what it looks like by typing FOURSQUARE or whatever you chose to call it. After you try yours, check to see if it looks like what is on card #17. Pause the tape.

This procedure tells the Turtle to repeat the set of commands BOX and then RT 90 four times. The Turtle will draw the BOX, turn right 90, draw the BOX, turn right 90 four times in all. Try defining some other procedures for the Turtle using the BOX or NEWBOX procedures. How about a

tower of boxes? A leaning tower? Pause the tape now and experiment by defining some new commands with your BOX procedure.

Any new words that you define for the Turtle (procedures you write) can then be used to define new words or procedures. What could you do with your FOURSQUARE procedure? Try the same pattern you used in TO FOURSQUARE (repeat some number of times, FOURSQUARE, then turn). Your procedures might look like what is on card #18.

The FUN procedure uses the subprocedure FOURSQUARE, which in turn uses the subprocedure BOX. The ability of Logo to do this is what sets it apart from other languages such as BASIC. Many shapes that look really hard at first are actually pretty easy with Logo. See if you can teach the Turtle some other shapes to draw. What about a rectangle? Use REPEAT with some new designs and see what happens. Pause the tape and play with it for awhile.

Let's say our young Logo student has defined the procedure for BOX. She then teaches the Turtle how to POINT. Her procedure is what you see on card #19. Pause the tape and enter those commands, proofreading carefully to make sure it is exactly as written. Press control C to define the procedure, then test it out and see what it looks like by typing POINT. Card #20 shows what you should see. If not, erase POINT and try again.

Our young Logo student plays with POINT for awhile and then decides she would really like to draw a house. She draws a sketch, which looks like what you see on card #21. Our student could begin to define the house procedure by combining FDS, BKS, LTS and RTS. But when she looks closely at her sketch she realizes that the Turtle already knows how to draw something that looks like the base of the house, her familiar BOX procedure, and the Turtle also knows how to draw the roof shape- it looks like her point (see card #22). Maybe she can put those two procedures together to get her house. By defining one object in terms of other simpler objects, the child is encouraged to think procedurally, to derive one concept from another and in so doing discover the relatedness between concepts. She can break the house problem down into what Seymour Papert calls "mind-sized bites" and use these procedures to define her house. Enter the HOUSE procedure as on card #23. When you

try it by typing HOUSE, be prepared to see something you didn't expect. Pause the tape and define HOUSE.

If you made no typing errors, what you see should look like what is on card #24. Your first reaction to this might be "That's all wrong! I'll erase it and try again." Don't. In the computer world things hardly ever work out right the first time, as you may have discovered already. Sure, it's not exactly what you expected, but it really is kind of neat. You may want to save this design to use later in another drawing. The question is not "is it right or wrong?" but "is it fixable?" Thanks to the computer culture, we now even have a word for this - debugging. This is a very powerful idea and one that is not commonly found in schools today. The children's answers are usually judged with right/wrong, black/white types of logic. In real life, there are many shades of gray. Take another look at our house as on card #24. There really is more that is right about it than wrong. It is exactly the shape we want only it's lying on its side. We need to turn the whole thing right 90. We'll write a new procedure to solve this problem. Remember, you can call your procedures anything you like. I'll call it NEW.HOUSE. Look at card #25. The period between the W and the H makes it look like NEW.HOUSE is two words, but since there really is no space there, Logo reads it as one word. Type in the procedure for NEW.HOUSE now, define it with control C, then try it and see what happens. It should look like our young student's sketch on card #22.

In the short time that you have been experimenting with Logo, you have probably made some important discoveries about the Turtle and how it moves, about problem-solving and thinking about thinking. The processes you have gotten in touch with are much more important than any product or picture we got on the screen. When children interact in the Logo environment, playing, experimenting, debugging, they learn what the Turtle can do by forming a hypothesis, trying it out, noticing what happens and debugging, or rethinking their strategies. This is learning in the true Piagetian sense.

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Appendix G

Reference Cards for Student-controlled Module

CARD #1

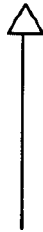
? SHOWTURTLE

CARD #2

? FORWARD <RETURN>

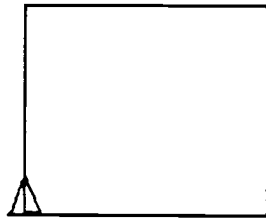
CARD#3

FORWARD NEEDS MORE INPUTS

CARD #4DRAW <RETURN>
FORWARD 50 <RETURN>CARD #5CARD #6DRAW
FORWARD 50
RIGHT 90CARD #7

CARD #8

FORWARD 50
 RIGHT 90
 FORWARD 50
 RIGHT 90
 FORWARD 50
 RIGHT 90

CARD #9CARD #10

TO BOX

CARD #11

FORWARD 50
 RIGHT 90
 FD 50
 RT 90
 FD 50
 RT 90
 FD 50
 RT 90

CARD #12

ERASE BOX

CARD #13

TO NEWBOX
 REPEAT 4 [FD 50 RT 90]

CARD #14

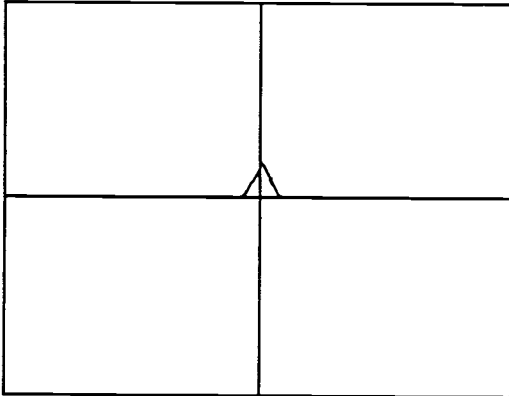
RT 45 (or whatever number
 you like)
 BOX

CARD #15

REPEAT 8 [RT 45 BOX]

CARD #16

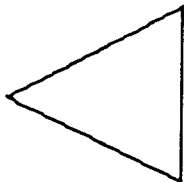
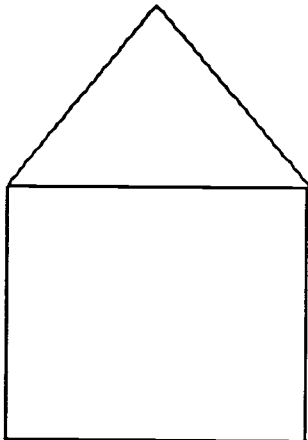
TO FOURSQUARE
 REPEAT 4 [BOX RT 90]

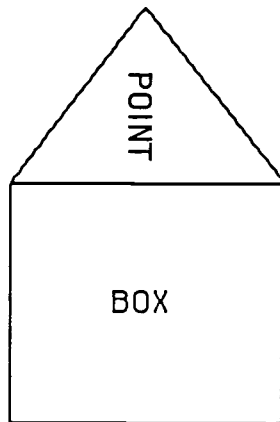
CARD #17CARD #18

TO FUN
REPEAT 2 [FOURSQUARE LT 45]

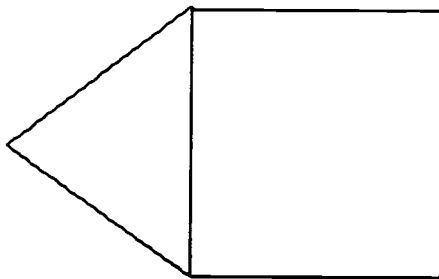
CARD #19

TO POINT
REPEAT 3 [FD 50 LT 120]

CARD #20CARD #21

CARD #22CARD #23

TO HOUSE
BOX
POINT

CARD #24CARD #25

TO NEW.HOUSE
RT 90
HOUSE

Appendix H

"Turtle Talk" Reference Sheet

Commands that are single keypresses are enclosed with < >. Other commands are in capitols.

SHOWTURTLE	Places you in the DRAW mode so you can create designs with the Turtle.
<ESC>	Erases the character to the left of the cursor and backspaces one space.
<RETURN>	Sends commands to the computer for execution.
FORWARD (FD)	Moves the Turtle forward the number of steps specified. Example : FORWARD 50
BACK (BK)	Moves the Turtle backwards the number of steps specified. Example: BACK 50
LEFT (LT)	Rotates the Turtle counterclockwise the # of degrees specified. Example: LEFT 90
RIGHT (RT)	Rotates the Turtle clockwise the number of degrees specified. Example: RIGHT 90
DRAW	Clears the screen and sends the Turtle "HOME" (in the center facing up).
<CTRL> F	FULLSCREEN: Lets you see the full drawing screen without the 4 lines of text at the bottom.
<CTRL> S	SPLITSCREEN: Lets you see the DRAW screen <u>with</u> the 4 lines of text at the bottom.
TO	Places you in the EDIT mode so you can define or edit procedures.
<CTRL> C	In the EDIT mode, defines the procedure and exits the EDIT mode.
<CTRL> G	Stops whatever is happening in Logo at the time and waits for a new command.
ERASE (procedure name)	Erases the procedure from the Turtle's memory.
REPEAT	Command that tells the Turtle to repeat the following set of commands the specified number of times. Uses the square brackets. Example: REPEAT 4 [FD 50 RT 90]

Appendix I

Data from Field-test of Treatments

Module 1 (Program-controlled) n = 17

	<u>Time</u>	<u>Difficulty</u>	<u>Interest</u>
	60	3	3
	40	2	2
	35	1	4
	40	2	3
	42	3	4
	50	2	2
	40	1	2
	35	1	4
	40	2	4
	35	2	4
	40	1	4
	40	1	3
	35	2	2
	35	3	3
	33	3	4
	50	3	4
	<u>45</u>	<u>2</u>	<u>4</u>
Total	695	34	56
Average	40.9	2.0	3.29
Range	33-60	1-3	2-4

Module 2 (Student-controlled) n = 17

<u>Time</u>	<u>Difficulty</u>	<u>Interest</u>
79	2	4
75	2	2
100	4	4
80	2	3
51	2	4
45	2	3
41	2	4
50	2	3
60	1	3
45	2	4
53	2	3
35	2	3
54	2	2
90	2	3
45	2	5
45	1	4
<u>50</u>	<u>2</u>	<u>1</u>
Total	998	35
Average	58.7	2.07
Range	35-100	1-5

Appendix J

Table 12

Distribution of Subjects by Age in Groups

Locus of Control	Instructional Method			
	Program-controlled		Student-controlled	
	n	%	n	%
Internals				
no response	1	3	0	0
18 or less	0	0	0	0
19 or 20	3	11	3	12
21 - 24	14	50	11	42
25 - 30	2	7	4	15
over 30	8	29	8	31
Externals				
no response	0	0	2	9
18 or less	0	0	0	0
19 or 20	5	26	8	36
21 - 24	9	48	5	23
25 - 30	0	0	2	9
over 30	5	26	5	23

Appendix K

Table 13

Distribution of Subjects by Class Standing in Groups

Locus of Control	Instructional Method			
	Program-controlled		Student-controlled	
	<u>n</u>	%	<u>n</u>	%
Internals				
Freshmen	0	0	0	0
Sophomores	1	4	1	4
Juniors	8	29	11	42
Seniors	13	46	11	42
Graduate Students	6	21	3	12
Externals				
Freshmen	0	0	0	0
Sophomores	0	0	1	5
Juniors	6	31	9	41
Seniors	10	53	9	41
Graduate Students	3	16	3	13