An Investigation into the Effects of Learner Control Options on Patterns of Learning Strategies

Debra Small Nelson

Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/dissertations

Part of the Teacher Education and Professional Development Commons

Recommended Citation
https://scholarworks.wmich.edu/dissertations/2347

This Dissertation-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Dissertations by an authorized administrator of ScholarWorks at WMU. For more information, please contact wmu-scholarworks@wmich.edu.
AN INVESTIGATION INTO THE EFFECTS OF LEARNER CONTROL OPTIONS ON PATTERNS OF LEARNING STRATEGIES

by

Debra Small Nelson

A Dissertation Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Doctor of Education Department of Special Education

Western Michigan University Kalamazoo, Michigan August 1985
AN INVESTIGATION INTO THE EFFECTS OF LEARNER CONTROL OPTIONS ON PATTERNS OF LEARNING STRATEGIES

Debra Small Nelson, Ed.D.
Western Michigan University, 1985

A body of literature termed learner control research examined the efficacy of allowing learners control over the type, rate, amount, and sequence of content to be covered in an instructional program. The growing impact of computer based education has enhanced the possibility of providing learners greater autonomy in the learning process. The purpose of this study was to investigate the effects of providing learner control options in a computer-assisted instruction (CAI) microcomputer program on patterns of learning strategies and content mastery.

The sample consisted of 98 adult learners involved in the fields of general or special education in the State of Michigan. Subjects were required to complete a CAI program in which the selection and sequence of six content options were controlled by the learner.

A pre-program questionnaire was used to collect demographic information important to the interpretation of the data. Data on the learning strategies were collected using a recording routine built into the CAI program. Content mastery was determined using posttest scores obtained from a True-False examination.

Analyses of the data collected resulted in the following conclusions:
1. Learners differ in the type, amount, and sequence of the instructional content they select.

2. Learners tend to select a practice problem option over other types of presentation format.

3. Learners exhibit an identifiable pattern of learning strategies.

4. Learners with prior knowledge and experience in a specific content area tend to select more content options than those without such knowledge.

5. The learning strategies exhibited by learners do not appear to affect test performance.

Hypotheses which stated that the frequency of a learning strategy and the time taken to complete the strategy would affect test performance were not supported.

The following implications were drawn from the findings:

1. Instruction should provide incentives to learners to explore additional material.

2. CAI should provide a practice unit prior to beginning instruction so that learners can familiarize themselves with the types of presentation formats.

3. CAI should provide learners control over the rate, type, mode, and amount of presentation if a posttest is also available to measure the learner's mastery of the content.
INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of “sectioning” the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.

University Microfilms International
300 N. Zeeb Road
Ann Arbor, MI 48106

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Nelson, Debra Small

AN INVESTIGATION INTO THE EFFECTS OF LEARNER CONTROL OPTIONS ON PATTERNS OF LEARNING STRATEGIES

Western Michigan University  
University Microfilms International  
300 N. Zeeb Road, Ann Arbor, MI 48106

Ed.D.  1985

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
ACKNOWLEDGEMENTS

The writer wishes to acknowledge those without whom this would not have been possible.

Particular recognition goes to Dr. Dona Icabone, Dr. Abraham Nicolaou, and Dr. Howard Poole, as committee members, for their support, and to all instructors and staff in the Department of Special Education, Western Michigan University, during the years 1973-1985.

Special appreciation belongs to Dr. Alonzo E. Hannaford, Dissertation Chairperson, for his constant support, wisdom, and friendship.

A special thanks is due Dr. Joseph Eisenbach, Department of Special Education Chairperson, for his support in many areas over the years.

This would not have been completed without the understanding and support given me by James A. Clark, Superintendent, and Larry L. Campbell, Assistant Superintendent, St. Joseph County Intermediate School District, the administrators in my employment during 1983-1985.

To my parents, Mr. and Mrs. Robert Small, who taught me always to do my best and more, for their love.

To my husband, John, whose encouragement and love made me continue when I didn't think I could and to Jill, who was always there when I needed her.
Lastly, I dedicate this to the late Theodore P. Bank, III, who I know is proud of this accomplishment.

Debra Small Nelson
TABLE OF CONTENTS

ACKNOWLEDGEMENTS ................................................................. ii

LIST OF TABLES ........................................................................ vi

LIST OF FIGURES ...................................................................... vii

CHAPTER

I. INTRODUCTION TO THE STUDY .................................................... 1

   Problem ................................................................................. 7

   Research Questions ................................................................. 8

   Assumptions ........................................................................... 9

   Definitions ............................................................................. 9

   Need for the Study ................................................................. 10

   Significance of the Study ....................................................... 10

   Organization of the Dissertation ......................................... 12

II. REVIEW OF THE RELATED LITERATURE ...................................... 13

   A Statement about Traditional Instruction ........................... 13

   An Overview of Selected Individualized Instruction Programs . 14

   The Relevance of Instructional Design ................................. 20

   The Impact of Computers on Individualized Instruction ....... 22

   Related Research on Learner Control ................................. 26

   Summary ................................................................................ 38

III. DESIGN AND METHOD ............................................................ 42

   Purpose of the Study .............................................................. 42

   Hypotheses ............................................................................. 42

   Instrumentation ...................................................................... 45

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
LIST OF TABLES

1. Number of Screens Per Option .................................................. 50
2. Demographic Data on Subjects for the Field Testing .................. 52
3. Demographic Data on Subjects for the Study ............................ 54
4. Frequencies and Percentages of Initial Learner Control Options ................................................................. 60
5. Frequencies and Percentages of the Stability Ratios ................. 62
6. Frequencies of LC Strategies Exhibited in Unit 1 .................... 64
7. Rank Ordering of Top Ten Strategies in Unit 1 .......................... 65
8. Summary of Most Predominant LC Strategies Across Units 1-5 ... 66
9. Total LC Options Selected by the Group Per Unit .................... 67
10. Analysis of Variance Stability Ratios and Test Performance ...... 68
11. Knowledge and Experience and Number of LC Options ............ 70
12. Analysis of Variance Stability Ratio and Time ....................... 71
LIST OF FIGURES

1. Sequence of the Learners Control Options .................. 48
2. Example of Option Selection Screen ...................... 50

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
CHAPTER 1

INTRODUCTION TO THE STUDY

It has often been said that we know more about individual differences and do less about them than we do in any other area of education (Goodlad, 1972). "One of the few definitive results of the scientific study of human behavior is the demonstration of individual differences, yet we have ignored that simple and obvious fact" (Cross, 1976, p. 9).

Since the early part of this century, educational theorists have voiced concern for individual differences (Cronbach, 1978; Gaff, Festa, & Gaff, 1978; Gagné, 1971; Gronlund, 1974; Musgrave, 1975). The recognition of these differences brought to the educational arena a consideration for the capabilities of the individual learner and an associated tendency to shift the responsibility for learning from the teacher to the learner (Gagné, 1971). The importance of the individualization of instruction is abundantly apparent throughout the literature. Yet, this principle has not necessarily gained a prominent place in educational practice.

For the past quarter of a century those involved in higher education have attempted to provide equal education for "all". Yet, mass education may be found to be inappropriate for the education of the masses. The situation may indeed be that the task of educators for the remaining years of this century will be to work to achieve education for "each" (Georgiades, Hilde, & Macaulay, 1977).

The very diversity of the masses in higher education today calls
for the abandonment of mass education (Cross, 1976). The diversity challenges the techniques and methods of the past, even though they adequately served to meet past needs (Weisberger, 1971). Historically, the traditional teaching method in the university has been the lecture method. This method of instructional delivery has endured and even flourished for centuries. Research reveals that some students require the structure, unambiguity, and guidance that the lecture provides (Pascal, 1971). The effectiveness of the lecture method in meeting the individual needs of the learner, however, has been questioned (Cole, 1978). The question is focused on the apparent contradiction of using group instruction to meet individual needs. Instruction provided to 20-30 learners in a group is likely to be very effective for some but not for others. Typically, the top third or fourth of the group receives the greatest attention and encouragement by the teacher, whereas the bottom third or fourth receives the least attention and encouragement (Bloom, 1978). In traditional instruction, some students become well-educated and some do not, yet the justification of group instruction was founded on the point that all students spent the same time learning the material (Cross, 1978).

A wide variety of innovative instructional methods geared to individualized instruction have received partial acceptance in higher education. Personalized System of Instruction (PSI), programmed instruction, mastery learning, and computer-based learning are among these. Gartner and Sunderland (1974) stated the ideal behind these approaches is to make learners the producers of their own learning and to focus on learning how to learn rather than upon mastery of
content (Cole, 1978). Although these approaches have been acclaimed as successful throughout the literature (Cole, 1978; Cross & Semb, 1976; Pascal, 1971), the tendency has been for each approach to eventually lose its momentum in educational practice.

The fact still remains that a technology of teaching based on the principles of individualized instruction is gaining momentum in the field of education (Cross, 1978; Esbensen, 1978; Fraley, 1980; Keller, 1980). There is a growing belief that instruction can be designed more systematically than has traditionally been the case. An inter-related system of objectives, materials, and evaluation procedures can be designed (Briggs & Wager, 1981). Tickton and others cited in Cole (1978) described this instructional technology as a

systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and human communication, and employing a combination of human and nonhuman resources to bring about more effective instruction. (p. 37)

Gagne (1971) has advocated that "the only essential part of an educational system is the learner" (p. 26). What can be said about the characteristics of the individual learner? We now know that there are significant differences along the main dimensions of learning (Cross, 1978). Many educational researchers agree that these differences exist among the following: learning rate, learning style, motivation and interest in various types of learning tasks, learning needs, and personal preferences (Bell, 1974; Bloom, 1978; Briggs, 1971; Budoff & Hotten, 1982; Cole, 1978; Gagne, 1971; Goldschmid &
Goldschmid, 1976; McKeachie, 1970; Tyler, 1967). The obvious solution then, to maximize impact on the development of individuals, is to offer options to the learner. If learning is something done by the learner, instead of for or to him, options that allow for active participation by the learner would seem to maximize learning. This active participation in the learning process by the learner through the presentation and selection of options has been referred to as learner control (LC).

The beginning of research concerned with learner control occurred a short 20 years ago. This is a relatively new field, with little systematic study, in comparison to the massive research effort on individualized instruction, both temporally and in the number of studies to date.

Apparently, the first study which addressed the area of learner control was conducted by Mager (1961) to determine if a learner would sequence instruction differently from an instructor. A second study (Mager & McCann, 1961) afforded the learner control over the sequence, delivery, and pace of instruction. Significant results, in support of the effectiveness and existence of learner control abilities were reported (Mager & Clark, 1969). Yet even 20 years ago, Mager and Clark (1963) noticed a contradiction, which would be reiterated by others time and time again.

The incredible thing is that we are well aware of the existence of differences in student knowledge and experience. At the same time, however, we behave as though we wished this difference would go away . . . the overwhelming tendency is to force each learner to work his way through exactly the same sequence of information. (pp. 57-58)
The emphasis of learner control research shifted in focus with the advent of computer technology. Computer-assisted instruction (CAI) became increasingly popular in the late 1960's with the introduction of two large-scale computer systems called PLATO (Programmed Logic for Automatic Teaching Operators) and TICCIT (Time-shared, Interactive, Computer-controlled, Information Television). The potential of computer hardware and software to individualize instruction in higher education was recognized. As the technology became more sophisticated, many researchers in the field realized the capacity of the computer to offer learner control options within an instructional program and to allow for the systematic, controlled analysis of learner control strategies (Bell, 1974; Bundy, 1978; Hickey, 1968; Judd, 1971, 1972; Lahey & Coady, 1978).

This capacity was studied extensively throughout the 1970's at two locations: the Computer Laboratory at Texas University in Austin, Texas (Judd, undated, 1971; Judd, Bunderson, & Bessent, 1970; Judd, Daubek, & O'Neil, 1975; Judd, O'Neil, & Spelt, 1974) and the Naval Personnel Research and Development Center at San Diego, California (Lahey & Coady, 1978; Lahey, Crawford, & Hurlock, 1976; Lahey, Hurlock, & McCann, 1973; McCann, Lahey, & Hurlock, 1973; Merrill, Olsen, & Coldeway, 1976). However, the results of this research have not been widely discussed in the educational literature and therefore have not significantly impacted this field.

The term learner control has only been vaguely defined by interested researchers and, at times, in conflicting manners. This is seen as a disadvantage in discussing the results of such research.
Basically, learner control

is generally understood to refer to a situation in which decisions as to a student's route through an instructional program are made by the student himself rather than being predetermined or made on the basis of a preprogrammed response sensitive algorithm. (Judd, undated, p. 1)

The majority of learner control studies have taken place in the realm of computer-assisted instruction. The learner has been investigated when given control over the sequence of instruction in linear and branching programs (Judd, undated; Judd, Bunderson, & Bessent, 1970; Judd, Daubek, & O'Neil, 1975; Judd, O'Neil, & Spelt, 1974; McCann, Lahey, & Hurlock, 1973), the number of times an instructional segment is viewed (Judd, Bunderson, & Bessent, 1970; Lahey, 1978), the choice of remediation (Lahey, Hurlock, & McCann, 1973), and the selection of different learner strategies (Lahey & Coady, 1978; Lahey, Hurlock, & McCann, 1973; Merrill, 1974).

The general agreement concerning which options should be available for learner control can be summarized as follows:

1. The learner should have complete control over the sequence or order in which he selects the lesson segments or objectives.

2. Having selected a lesson segment or objective, the learner should have complete freedom of choice over the type of content viewed for the objective or segment (e.g., rules, examples, practice, review).

3. Having selected a type of content, the learner should have complete freedom of choice over the level of difficulty of the content presented (e.g., easy, medium, or hard).
4. The final lesson segment, the final quiz, should be available as an option in regard to the point at which it is taken and the number of times it is viewed (Lahey, Crawford, & Hurlock, 1976).

With the exception of Lahey and his associates (Lahey, 1978; Lahey & Coady, 1978; Lahey, Crawford, & Hurlock, 1976; Lahey, Hurlock, & McCann, 1973), the systematic analysis of learner control strategies has not occurred. Little evidence of the effectiveness of allowing the learner the above listed options has been gathered. It is possible that there was not available a means to collect these data. Learner control research utilizing the microcomputer as a data collection tool is now possible.

Problem

An extensive review of the literature and research available on the topic of learner control provided ample evidence that the systematic analysis of learner control strategies exhibited by learners through control options has not been sufficiently studied. Instead, what has surfaced from the research are many statements regarding the effectiveness of learner control in regard to test performance, time required to master an instructional sequence, and learner attitude toward learner control options in a CAI program. The lack of specificity, with regard to the analysis of the pattern of learner control strategies is a main gap in the field of learner control research.
Research Questions

The purpose of this study was to examine the patterns and the stability ratios (SR) of learner control strategies exhibited by learners when provided with learner control options. The study was directed toward the following specific questions:

1. Is there a difference between the initial learner control options selected by the individual learners in the instructional program?

2. Do the learner control strategies exhibited by an individual learner remain consistent throughout the instructional program; i.e., do individual learners exhibit a high stability ratio of LC strategies in the instructional program?

3. Does the preferred pattern of learner control strategies of an individual learner differ from the pattern of other learners?

4. Is there a relationship between the stability ratio of LC strategies and test performance of the instructional content by the learners?

5. Is there a relationship between the time required to complete an instructional CAI program (the pattern of LC strategies and its accompanying stability ratio) and test performance of the instructional content by the learners?

6. Is there a relationship between the individual learner's base of knowledge and experience in the content area and the pattern of LC strategies chosen by that learner?

7. Is there a relationship between the time taken to complete the program and the stability ratio of an individual learner?
Assumptions

The research questions were formulated upon the following assumptions:

1. Learner control is a viable means to individualize instruction.
2. The term learner control can be operationally defined for researchers and practitioners in the fields of education and computers.
3. Learners can use control options successfully.
4. Microcomputers can be utilized to effectively present control options to the learner.
5. Microcomputers can effectively record the learner control strategies exhibited by the learner.

Definitions

The following terms were defined for purposes of this study:

- **Learner control options** - the choices made available to the learner which were: the lesson, restatement of the lesson, examples, definitions, and practice problems. These five choices comprised a unit.

- **Initial learner control option** - the first learner control option selected in the first unit.

- **Learner control (LC) strategy** - the sequence of learner control options selected by a learner in each unit.

- **Stability ratio** - the percentage of units in which the learner control strategies of the learner are exactly the same.
Preferred learner control (LC) strategy or pattern - the LC strategy most often selected by the learner when given control options in an instructional sequence.

Need for the Study

There has been a failure in many studies to take into account individual differences in response to learner control (Judd, O'Neill, & Spelt, 1974). Therefore, further research needs to be directed toward the identification of individual differences (Judd, 1972). Over 15 years ago, Hickey (1968) recognized the unique opportunity available through computer technology to collect detailed records of learner strategies. In other words, one can use the computer as a way of learning about learning. This type of research should add to the development of a theory of instructional design for educators and microcomputer programmers. Education has never had such a unique opportunity to perform this task (Bundy, 1978).

Specifically, in regards to the lesson strategies of learners, further research has been recommended by Lahey and Coady (1978) in order to determine if learners exhibit a dominant strategy. The present study most closely approximates their work.

Significance of the Study

The identification of the pattern of LC strategies may begin to answer some of the questions that educators and computer program designers have concerning the utility and viability of learner control options. While some broad generalizations have been expressed, little
In the way of specificity has emerged.

No one can doubt the emergence and growing popularity of computer assisted instruction in our nation's schools. There are an estimated 630,000 microcomputers in place (SCADS, 1984). Computers are purported to be changing the nature of what needs to be learned, who needs to learn it, who will provide it, and how it will be provided and paid for (Shane, 1982). Special education will not be unaffected. Many special educators are already discussing the varied uses of microcomputers with handicapped populations (Cohen & Schwartz, 1983; Riegel, 1984; Torgesen & Young, 1983). Still, research regarding computer assisted instruction with handicapped learners is limited by small sample sizes, weak research designs, and the failure of such studies to appear in the leading journals (Riegel, 1984).

This study attempted to analyze individual differences in learning. Possible outcomes included:

1. Evidence that a way exists to systematically document learners' patterns of learning strategies as they proceed through an instructional sequence.

2. Evidence that this documentation would aid in analyzing individual differences.

3. Evidence that learners do not always select the "best" way to learn. Educators will need to have a means to identify those students who make wise choices and those who do not.

4. Evidence that a learner's knowledge base about a content area influences his/her way of learning about a subject.

All of the above points may also be of interest to the developer.
of computer assisted instruction, for both handicapped and non-handicapped populations.

Organization of the Dissertation

Chapter I has served as an overview of the basic purpose and problem of the study. Included within this first chapter are an introduction, a statement describing the problem, assumptions underlying the study, the research questions, definitions of relevant terms, a statement about the need for the study, and a statement about the significance of the study.

Chapter II, Review of the Related Literature, contains a detailed review of the literature in the following sub-areas: a statement about traditional instruction, an overview of selected individualized instruction programs, the relevance of instructional design, the impact of computers on individualized instruction, and the related research on learner control.

Chapter III, Design and Method, contains a description of the sample, the hypotheses, the method employed, and the setting. It also includes a section on the development of the computer instructional program. The data collection and data analysis procedures are also explained.

Chapter IV, Report of the Findings, includes the analyses of the data collected in the study.

Chapter V presents a summary of the study, a discussion of the major findings and their implications, the conclusions drawn from the findings, and recommendations.
CHAPTER II

REVIEW OF THE RELATED LITERATURE

Information presented within this chapter provides a review of the related literature and research addressing the active role of the learner in learning. The included literature has been selected for the relationship it has to the hypotheses, problem, and research design implemented within this study.

Organization and presentation of the information is as follows: (a) a statement about traditional instruction; (b) an overview of selected individualized instruction programs; (c) the relevance of instructional design; (d) the impact of computers on individualized instruction; and (e) related research on learner control.

A Statement about Traditional Instruction

Within higher education, traditional instruction has frequently not been individualized. As has been previously indicated, it has most often been the practice that instruction is delivered in the format of the lecture and textbooks have served as the major visual presentation medium (Hannum & Briggs, 1982). Instruction occurs over a fixed, predetermined length of time. Every student begins at the same point of content and proceeds at the same rate. Instruction is sequenced according to the logical structure of the content. The important requirement is for the instructor to be an expert in the content area; it is not considered critical to be knowledgeable about...
how students learn. Hence, it is implied that it is not essential for
the instructor to be an expert in the applied science of education
(Vargas, 1980).

The lecture system is composed of a largely fixed curriculum with
common branches of knowledge to be learned. Individual differences
are recognized by the elimination of those students who cannot be-
have like the masses. Success by some and failure by others is ex-
pected. It is not the school's responsibility or capability to alter
the innate abilities of the learner.

Over the years, highly respected authorities have questioned the
efficacy of the lecture method (Cole, 1978; Hickey, 1968). It has
been said that, at any point in time, only 12% of a lecture audience
is attentive to the lecturer. Lecture does not require students to
make responses or maintain attention. This too has been a source of
criticism. Hannum and Briggs (1982) summarized the major criticism
of the lecture method as the highly unpredictable nature of the qual-
ity of instruction, which often is not determined at all. The focus
is on the instructor, not the learner (Gaff, Festa, & Gaff, 1978). The
lecture method dominated instruction until the emphasis on edu-
cation began to shift from the instructor to the learner with the
introduction of individualized instruction.

An Overview of Selected Individualized
Instruction Programs

The realization and fulfillment of one's potential is founded
in our nation's ideals (Talbert & Frase, 1972). The history of Ameri-
can education is replete with concern for the capabilities of the
individual student. In the decades immediately preceding the 1960's, the lockstep curriculum of education could not be changed. Before instruction which focused on the learner could be accepted, an agreement that individual differences existed in and among learners had to occur (Musgrave, 1975). As this philosophy gained momentum, concern slowly shifted from the group to the individual.

A wide variety of innovative teaching techniques and methods were offered as a means of including the learner as an individual. These have collectively come to be known as the individualization of instruction. Individualization has no precise meaning (Jeter, 1980). Many different approaches are encompassed under the umbrella of individualized instruction (See, 1978). In an Educational Resources Information Center (ERIC) search conducted in 1980, over 1,200 entries dealt with individualized instruction (Katzenmeye & Ingison, 1980). Cross (1976) went so far as to call this the Instructional Revolution. However, most of the plans were developed on a small scale and not generalized to the population of learners as a whole (Talmage, 1975).

In 1954, a revolutionary new approach to individualized instruction appeared--programmed instruction. It was developed by B. F. Skinner through laboratory investigations, in connection with the teaching strategies of Norman Crowder (Davies, 1973). The system was composed of many a-b-c combinations called frames: (a) the student was presented the content; (b) the student actively responded; and (c) the student received immediate feedback as to the correctness of the answer. The student had an active role. Teaching machines were later used to present the frames.
Quite soon after the introduction of programmed instruction, programmed textbooks and materials were being mass produced. It appeared that programmed instruction would become commonplace in the schools (Loughary, 1978). Many research studies were conducted as to the effectiveness of programmed instruction. The results of such research were summarized by Williams (1966) as follows: (a) the effectiveness of programmed materials is, at times, greater than for human teachers; (b) frequently, no differences in effectiveness could be found; (c) programmed instruction takes less time; and (d) short- and long-term retention of content was evidenced (Davies, 1973).

The forecast of the widespread use of programmed instruction did not materialize. Many explanations have been offered. When whole classes were taught using programmed instruction materials, without regard to individual differences, it was not successful for all students and teachers. Suitable materials were difficult to find. Some students found the materials boring and others could not master the material (Gage & Berlinger, 1979). Yet the approach did contribute some new ways of thinking about instruction. Perhaps the greatest contribution of programmed instruction was the introduction of a commitment by educators to a sound technology of instructional materials (Gage & Berlinger, 1979; Jurgemeyer, 1982).

In the 1960's, the Keller Plan, or Personalized System of Instruction, had a major impact in the educational field. Initially used at the University of Brasilia in 1964, PSI was developed by F.S. Keller and J. Gilmour Sherman (Ruskin, 1974). The system has five defining features. The courses are individually paced,
mastery-oriented, and student proctored. A few lectures are included and the format is tutorial.

As with programmed instruction, there was a flurry of excitement in the educational field. The idea of self-paced instruction was a novel one indeed. Students could choose where and when to study. Perhaps this was the first large-scale acceptance of individual differences and a small learner control option. Yet PSI did not create significant changes in the educational methodology practiced in the schools (Gallup & Waranch, 1978; Wilkins, 1972).

Close to the ideas of programmed instruction was Bloom's mastery learning approach, first described by Bloom in 1968 (Bloom, 1978). This approach was set in the belief that all students should achieve a specified level of mastery. Bloom made adjustments for individual differences by adding feedback-corrective techniques to traditional instruction and allowing students to progress toward mastery at their own pace. Self-pacing was the most commonly followed concept in the efforts to individualize instruction (Tyler, 1967). This was deemed essential since schools serve students with widely diverse learning histories (Hursch, 1976). Jeter (1980) suggests the mastery learning concept was the most influential force providing direction for change within the educational system.

Hence, it seems that there was a heightened interest in individualized instruction in the 1950's and 1960's. Still, many authors said the same thing about the 1970's. Possibly this was due to the acknowledgement that the topic of individualization needed further study (Peterson & Walberg, 1979).
There is a growing disenchantment with the practices of the educational system on the whole to continue instruction in which students are required to pursue learning at the same pace, at the same time, and in the same manner. Although approaches have been developed that allowed students control over the pace and the set time to learn, attempts to vary the instructional materials and activities among students is relatively unexplored (Esenben, 1978).

During the past decade, there has been a gradual increase in interest in the possibility of offering options to students which would enable them to make choices individually suited to their needs (McKeachie, 1970). In this conceptualization, learners would actively engage in the process of decision-making. Students would assume an active role in their learning; a role not often emphasized in the educational system (Wolfson, 1972). Within this concept, the focus begins to shift from teacher behavior to learner behavior.

A logical question surrounding the offering of student learning options is, "How much responsibility should the learner have and how much is he/she capable of assuming?" The idea requires a substantial amount of research. Studies began in the early 1970's (Judd, undated, 1971; Judd, Bunderson, & Bessent, 1970; Judd, Daubek, & O'Neil, 1975; Judd, O'Neil, & Spelt, 1974). Educators were cautioned that allowing students control over their learning might meet the goal of student responsibility, but other goals, such as effective learning, might be sacrificed (Pascal, 1971). Another concern was the lack of research delineating the skills necessary for the student to make decisions about his/her learning process. The specific need for knowledge
about the learner by the teacher was emphasized as a topic for future research (Weisberger, 1971). It was believed that this knowledge was essential to help guide student-directed learning, in terms of teaching students how and when to make decisions in instructional programs.

Self-directed learning refers to a situation in which the student has the freedom to choose what is to be learned, how it is to be learned, when it is to be learned, and how to evaluate his own progress (Della-Dora & Blanchard, 1979). These kinds of choices, in part or in total, comprise a student's learning strategy. Decisions can be made in regard to the pace of instruction, the level of difficulty of the instructional materials, the relevance of the material as determined by the student, the level of interest, and the individual learning style of the student (Kapfer, 1972). But are learners capable of making these decisions?

Several of the major approaches classified as individualized instruction have been described. The literature is replete with indications that many of these approaches have not lived up to their expectations (Cole, 1978). Programmed instruction has been faulted for encouraging rote learning and for forcing learner conformity to those responses in agreement with the program content (Gage & Berlinger, 1979). It has been noted that certain students cannot work in the type of learning environment present with the Keller Plan (Cole, 1978; Gage & Berlinger, 1979). Finally, it has been suggested that acceptance by a majority of authorities in the educational field "often determines whether an innovation affects real educational changes or merely joins the ever growing list of instructional fads or gimmicks"
Why has individualized instruction failed to impact significantly on the field of education? Is it possible that educational leaders in individualized instruction have lacked sufficient knowledge about learners' strategies upon which to base their programs and, therefore, their support? Could it be that the educators in the field did not attempt to understand the theories of learning behind the approaches developed? Or was it because allowing choices in pacing and time of instruction were not enough? Perhaps the answer lies in all of these.

The Relevance of Instructional Design

The underlying theme in individualized instruction is that there should be a systematic, orderly, replicable instructional methodology. The principles used in the design and delivery of instruction have been termed instructional design, systematic instruction, instructional development, and educational or instructional technology (Cole, 1978; Hannum & Briggs, 1982). The phrase "Instructional design" is used to refer to all or any of these. It does not imply any particular approach. It simply recognizes the complexity of teaching (Vargas, 1980).

The attempt to systematically design and deliver instruction is at the heart of all educational practices. But there exists a difference in philosophy between the traditional educator and the instructional designer.

The educator's traditional role was viewed as the transmitter of
information to students. He was to be an expert in his field of knowledge and have the ability to organize and convey content. The instructional designer's role is viewed as the creator of change in the behaviors of the student. Instead of focusing on the content, the instructional designer watches the student. Teaching is seen as the arrangement of conditions to produce changes in student behavior.

This disparity between the two roles created conflict (Markle, 1970). The instructional designer wanted the teacher to change his behavior and focus on the learner. The instructional designer brought attention to the added dimension of the learner as an active force in the development of instruction. If instruction failed (the student did not learn) it was not viewed as the student's fault, rather some aspect of the instruction was wrong. The traditional educator viewed the failure as a problem with the student.

If one sides with the philosophy of instructional design, the promise of effective instruction then lies in educators studying the student to find out which aspect(s) of instruction produces success and failure. Instruction must be matched to the learning task and to the characteristics of the learner (Hannum & Briggs, 1982; Robb, 1974). The characteristics of the learner, in part, determine the design of the instruction (Markle, 1970). If there are different characteristics within and among learners, then should not instruction vary with the student and with the group? With the development of computer technology, this opportunity to match instruction to the individual was seen as more easily attainable.
The Impact of Computers on Individualized Instruction

The use of computers has spanned two and one-half decades. In the late 1950's, the computer industry began using computers in its personnel training programs (Kulik, Kulik, & Cohen, 1980). Moore (1967) stated that "ten years ago, the notion of using sophisticated technology as an essential part of education was an abstract possibility" (p. 34). The testing of this possibility began in 1965 with funding by the U. S. Office of Education and the National Science Foundation for computer projects in education.

In the late 1960's, the National Science Foundation funded the first two large-scale computer projects for $14,000,000, PLATO and TICCIT. PLATO is an education network of 1,000 computer terminals located at the University of Illinois. There are many sites, linked by means of telephone lines, with each site having access to a central program of lessons. Subject areas include Russian, French, Latin, physics, biology, political science, veterinary medicine, economics, accounting, music, and engineering. The TICCIT system is located at the Mitre Corporation in Bedford, Massachusetts and has 128 terminals for each system. TICCIT is designed to operate with terminals in a learning resource center. A unique feature of the TICCIT system is the "learner control" keys which allow the learner to choose the instructional displays in the sequence he/she desires (Merrill, 1974). The TICCIT system introduced and emphasized "the idea of display or strategy control" (Merrill, 1974, p. 89).

Computer-assisted instruction has been defined as "the use of
computer for direct instruction of students" (Edwards, Norton, & Taylor, 1975, p. 147) and is often used interchangeably with the term computer-based instruction (CBI). CAI was proclaimed "the technology to talk about" in the year 1967 (Stewart, 1967, p. 54). At that time there were approximately 140 CAI programs available. During the late 1960's and early 1970's the educational field rapidly increased its involvement with computers (Solomon, 1974). Computer production multiplied dramatically during the 1970's. Throughout history until 1980, approximately 1,000,000 computers were manufactured. Hofmeister (1982) predicted that one million computers would be produced in 1982 alone and just by the top three or four manufacturers. In 1968, Hickey suggested that there is usually a 30 year lag between innovation and the widespread adoption of an approach. It appears from the literature we are closely reaching widespread adoption of computer usage in many fields in our society.

Even as early as 1967, Stewart implied that the evolution of computer technology had taken a backward approach; the technology was identified first and then a determination of the need for that technology occurred. What has been learned from this technology?

Gleason summarized the effectiveness of CAI in four main points: (a) CAI does not affect retention (b) it can be effective, (c) it can be time-saving, and (c) it is positively accepted by students (1981). Solomon (1974) had noted earlier the time-saving feature of computers.

Kulik, Kulik, and Cohen (1980) conducted a meta-analysis of the findings of computer-based instruction in higher education. The
authors concluded that, overall, the effectiveness of CBI in college settings was modest. They added that the Keller Plan or Personalized System of Instruction had produced far greater results.

In the late 1970's, researchers at the Educational Testing Service conducted a comprehensive evaluation of the PLATO and TICCIT systems. This is the largest scale evaluation of CAI that has ever been attempted (Katzenmeyer & Ingison, 1980). Findings of the evaluation were similar. Students and instructors favored the PLATO system over traditional instruction, but no significant effects on student achievement were found. The evaluators of the TICCIT system reported a slightly significant effect of CBI, but the student dropout rate was higher than for those attending conventional classes. Again, the potential so long claimed for CBI was not confirmed (Kulik, Kulik, & Cohen, 1980).

What went wrong? Many things were operating in favor of CBI. The technical speed, accuracy, and memory-storage capacity of the computer far exceeded that of a human teacher (Cole, 1978). CAI leans heavily toward the principles of individualized instruction (Solomon, 1974).

The assumption that all learning progress is linear was abandoned with the introduction of computers. Due to their ability to utilize branching, it was no longer accepted that all individuals are only at different points on a single continuum of knowledge. The dream was one of having students choose their own paths and schedules of learning to follow (Kulik, Kulik, & Cohen, 1980). Solomon (1974) summarized branching in this manner:
The computer can correct the student after incorrect responses and is capable of branching the student to additional problems when further help is necessary. Or, if the student has achieved a high level of performance, he can be branched ahead, skipping presentations of certain basic, low-level material. (p. 39)

There are basically two different schedules of learning. In a linear program, all students respond to a single path sequence and the same material. The computer will usually provide interaction in the form of feedback to a correct or incorrect response. In an intrinsic or branching program, there are several paths or branches in a sequence, and depending on the student's response, the program will present a certain path or paths to the student (Crowder, 1964). Program controlled learning closely resembles traditional instruction in which the teacher has complete control over all aspects of instruction.

Is it possible, as was the case in individualized instruction, that the principles of instructional design had again not been clearly delimited and therefore the effectiveness of CAI could not be determined? Several authors have expressed this viewpoint (Budoff & Hotten, 1982; Bundy, 1978; Gleason, 1981; Reigeluth, 1979). Budoff and Hotten (1982) attributed the "low utilization of CAI to an absence of adequate theories of instruction on which to base CAI systems" (p. 124). Empirical determination of the effectiveness of CAI may well have been hampered by this lack of theoretical bases of instruction.

Almost 20 years ago, educators were cautioned that "the technology of education may come to determine the methods and aims of
education itself" (Bundy, 1978, p. 361). Moore (1967) warned against forgetting the student since "most of the content which ultimately ends up in the computer can be obtained from the learner himself" (p. 36). The capacity to conduct research on teaching and learning under controlled conditions exists with the technology of computers. Its ability to maintain detailed records of student performance was recognized as early as 1968. However, more information is needed about learners. The potential to do so is here (Katzenmeyer & Inghamson, 1980) and has been here for a long time (Bundy, 1978).

Research on student responses to fixed conditions of instruction was requested by professionals as early as 1968, and there had been an interest in the unique patterns of student response throughout the 1970's (Hickey, 1968). Information regarding learning styles was still perceived as a need by Gleason in 1981. Budoff and Hotten (1982) stated that "discrimination of the benefits of CAI by learner type cannot presently be accomplished due to insufficient evidence" (p. 127). Maybe it has long been time to use the computer as a means to learn about learning, instead of only as a means to learn. Several researchers have done just that and though they are few in number, their findings about learner control are substantial.

Related Research on Learner Control

Traditional instruction has generally focused on the knowledge possessed by the instructor and the transmission of that knowledge to the learner. During the peak years of individualized instruction the emphasis shifted from the instructor to the learner. Individual
differences were recognized by the new approaches, such as programmed instruction, PSI, and self-directed learning. A questionable aspect of individualized instruction is the fact that the design of the instruction is based on individual differences with little input from the learner. It is believed that many individualized approaches fail due to inadequate instructional designs; that the characteristics of the learner have not been studied or integrated on any sufficient scale.

The means to study the characteristics of the learner changed when the computer reached the educational field. Considerable research on the use of computers in individualizing instruction has been conducted. The effectiveness of CAI has been noted, but in very limited ways. Did this also occur because we are still lacking adequate theories of learning in education? Researchers have spent an enormous amount of time studying the ends of instruction, but not the means. Those aspects concerning the delivery of instruction that were studied did not analyze the strategies of learners. The research on learner control is viewed as an attempt to fill this gap in the educational field.

The early research studies on learner control were conducted in non-computer instructional settings. The first study by Mager (1961) examined whether a learner would sequence instruction in the same way in which the instructor had sequenced it in past lessons. If the learner did, in fact, sequence instruction differently from the instructor, would this cause instruction to be more meaningful to the learner? The six subjects were given complete control options over a
curriculum in electronics. The control options available to the learner were: choice over the selection of topics to be discussed, the depth of instruction, the type and length of instruction for each topic, and the frequency and nature of review. The results provided evidence that learners chose a completely different sequence of instruction from that chosen by the instructor. A differing base of knowledge about electronics prior to the experiment was seen as an important determinant of the sequence of instruction chosen (Mager & Clark, 1969). Students chose their sequence based on the amount of knowledge they possessed about electronics prior to the study. Their knowledge base in electronics affected their choice of the sequence. Mager's work was unique in that he did not measure the effectiveness of the learner control options, but rather focused on the path or choices the learner took in an instructional sequence.

The second study prior to the CAI learner control research involved newly graduated engineers in a manufacturing division of Varian Associates (Mager & McCann, 1961). The students were provided LC options in an engineering course. All class meetings were cancelled. Students decided what they learned, when they learned it, and how they learned it. The students had a 24 page detailed course objectives packet which specified the desired terminal behavior. Results were a reduction in training time on the part of the student and instructor and better performance on the objectives than was true of past groups of students. Of importance is the fact that in this study students made individually different selections of content and sequences of instruction.
Along with the development of computers came the emphasis on CAI learner control research. Learner controlled CAI differs from conventional CAI in "that the student is given some degree of control over the means by which he has to learn the subject matter" (Judd, 1972, p. 2).

Several experts in learner control research recognized the adaptive potential of CAI to learner control of instruction (Judd, 1971; Lahey, 1978; Steinberg, 1977; Walker, 1978). These individuals attempted to define and delineate the parameters of learner control options, the learner strategies available and best suited to learner control, and those aspects of instruction which should be left open to the learner.

In the beginning years of the 1970's, learner control CAI research was being conducted in various educational settings. Oliver (1971), at the Ontario Institute for Studies in Education, taught an introductory science course in a CAI format. One hundred and sixty four college students, enrolled in an introductory psychology course for secondary teachers, were assigned to either a program-controlled or learner-controlled instructional sequence of the science course. The program-controlled instructional sequence was designed using the principles of a Gagne type behavioral analysis. Instruction was sequenced in a hierarchial format using task analysis. Both sequences were presented using an IBM 1500 system. The results demonstrated that the program-controlled sequence was most effective while the learner-controlled sequences yielded poor performance. The effectiveness of each sequence was determined by posttest results.
Judd began a series of learner control experiments at the Computer Assisted Instruction Laboratory at the University of Texas. The Laboratory served two functions: conducting research in improving CAI programs, and the development and implementation of CAI at the university level (Judd, 1971). The computer system utilized in all of the research was an IBM 1500 system with a capacity for five disk packs which controlled ten instructional terminals. Other components were model 1518 typewriters and model 1510 Cathode Ray Tubes with keyboard configurations.

Judd, Bunderson, and Bessent (1970) conducted an experiment in which 67 freshmen at the University of Texas were exposed to a MATHS course, a CAI course in remedial mathematics for college level students. The course was written by the researchers and controlled by the IBM 1500 system. The length of the course was not specified. The main objective of the course was to allow the student more control over his own course of study. The CAI program was composed of a Table of Contents format from which a student could make increasingly specific selections of course material and several modules containing course materials. The type of selections allowed depended on the amount of control afforded the student. The students were permitted to advance or return to a frame, return to the Table of Contents, look up words in a glossary, view test items, and enter a free comment.

There were four experimental conditions. Group 1 had full control over the course content through the use of the Table of Contents from which they could select the number of areas and the number of sections to be viewed. Groups 2 and 3 had some learner control
options available to them, but other options had been replaced by program control. Group 4 was under complete program control. The following conclusions were drawn: (a) allowing students control options in regard to the choice and order of topics, when compared to the predetermined sequence, had little beneficial effect on performance; (b) learner control did not result in improved student attitude toward the instruction; and (c) appropriate selection of topics may be dependent upon the competencies of the learner in the specific subject matter. The authors were inclined to suggest that learners can be competent judges of the amount of practice they require to master a topic. Overall, the provision of learner control over what material to view, the order, and the quantity of material did not have any significant effect on learner mastery.

Judd (undated) investigated learner control of instruction using 97 subjects in a 12-week CAI program of 1-2 hour blocks. The subjects were administered a 43 item multiple choice pretest. Subjects were randomly assigned to either a learner control program or a response sensitive branching algorithm which was operated totally by program control. Subjects could skip a test item (scored as an error), skip a question in a practice problem (scored as an error), exit the test sequence and return to the instructional module, access a glossary or set of drill problems, and enter a comment.

Two specific instructional strategies were examined: (a) whether or not a student should enter an instructional module given his pretest score, and (b) when a student should terminate practice. It was hypothesized that the LC subjects would select fewer modules and
Therefore their posttest scores would be lower. LC students effectively decided whether to study an instructional module, but they were not so efficient in deciding the amount of practice. LC students spent more time in practice than did program-controlled students and yet posttest scores were the same.

While Judd (undated) concluded that learner control had a role in CAI, he stated a need for further research to define the characteristics and limitations of that role. It was felt that smaller, well-controlled studies were needed. No specific data on the paths of the subjects through the program were given, though the conclusions appeared to be based on this type of information.

A learner-controlled strategy and a machine-controlled strategy were examined by Newkirk (1972) at the Computer Science Department, University of Western Ontario. Newkirk explained that "a decision strategy is said to exhibit learner control if the learner may consciously select the next content unit to be presented to him. A decision strategy is said to exhibit machine control if the learner makes no conscious selection of the next frame to be presented to him" (p. 83). She noted that the CAI programs available in the early 1970's, either linear or branching sequences, were mainly machine controlled.

Newkirk's study involved 26 subjects, 10 college students and 16 high school students. The CAI program was designed to introduce students to the language and functional design of the CLIP computer using either a LC strategy or a machine controlled strategy. The purpose was to determine if there would be a difference in the amount
of learning between the two groups and whether LC students would have a more favorable attitude toward the program.

The content was divided into four sequences, each defined by a block statement. The block statement states concisely the information to be learned in the block. The sequences were composed of several frames with five categories: statement, restatement, examples, practice problems, and criterion questions. The experiment was divided into two 1-hour lessons. The first lesson was preceded by a brief explanation of the sequence strategy. In the machine-controlled strategy, the learner played a passive role. In the learner-controlled strategy, the learner was an active initiator of his instructional process. Newkirk examined the effectiveness of each strategy by a posttest on content and an attitude questionnaire. It was concluded that the LC subjects learned as much as the machine-controlled subjects, exhibited better retention of the material, and held a slightly more favorable attitude toward the lessons. Newkirk had the opportunity, based on her program design, to analyze the subjects' individual paths through the instructional sequence, but she did not pursue this course of action. Yet she alludes to the fact that LC strategy research might provide an insight into individual learning differences. Again the ends, not the means, were examined.

After an extensive review of the LC literature prior to this time, Judd (1972) concluded the research in general had been quite inconclusive. The results of the LC research had basically supported the slight effectiveness of LC options over no options at all. The major question of interest that needed to be systematically examined
was which aspects of the instructional process are most appropriately made available for learner control. Judd (1972) suggested that individual differences among learners might be an essential factor in this determination. He stated that "learner control is not as simple an instructional technique as was first imagined" (p. 17). Research was required to determine the conditions when learner control is appropriate in CAI. Judd called for small scale laboratory studies instead of extensive treatments.

Merrill and his associates (Merrill, 1974; Merrill & Boutwell, 1972; Merrill, Olsen, & Coldeway, 1976; Merrill & Wood, 1974) attempted to first differentiate between learner strategy and instructional strategy and then to develop a taxonomy of instructional strategy. Merrill and Wood (1974) explained the difference between learner and instructional strategy.

An instructional strategy can be characterized as consisting of two or more instructional displays arranged in a specified sequence. Learner strategy consists of a series of learning moves by the student. A learner move consists of a particular overt or covert response to a particular instructional display or series of displays which enables the student to relate to the ideas being presented to previously acquired ideas in such a way that he can remember and use them at a later time. (p. 10)

Up to this time, most investigations of LC strategy were based on instructional strategies from various sources and opinions. No one had examined the strategies available to the learner. Merrill and others (1976) proposed a taxonomy of instructional strategy called the Instructional Strategy Diagnostic Profile. It has relevance to the present study only in its reference to learner control.
The taxonomy describes learner control as the option of the student to move to a section of a sequence at will.

Merrill et al. (1976) noted that learner control had been used in studies of content sequence, amount of practice, and content selection, but not yet in terms of learner control of strategy. This finding is important because of its recognition of the failure of researchers to look at learner strategies when providing control options. Call-Himwich and Steinberg (1977) added that "tracking the student's progress through the lesson becomes even more important when you allow them [sic] some autonomy" (p. 20).

Lahey and his associates (Lahey, 1978; Lahey & Coady, 1978; Lahey, Crawford, & Hurlock, 1976; Lahey, Hurlock, & McCann, 1973) have contributed to learner control research the majority of studies investigating learner strategies. They also were the first individuals to record and analyze the learner's path through an instructional sequence.

Lahey et al. (1973) initially studied two different ways to control adaptive branching in a CAI program. The subjects were 108 trainees in a basic naval electronics course. The program consisted of 11 lessons on AC series circuit analysis. The lessons were presented using an IBM 1500 system. One group was placed in a student-controlled mode in which the learner could choose training from a number of objectives. The other group had a program-controlled mode in which the learner could skip an instructional sequence only if he passed a criterion question first. Subjects in the student-controlled mode were also provided a remediation vs. no remediation control option.
The results showed no significant differences between the two modes on training time or final exam performance. Yet, since subjects preferred the student-controlled mode, based on an attitude questionnaire, this suggested that student-controlled materials should be developed and used whenever possible. Lahey et al. (1973) suggests these types of materials are easier to prepare than program-controlled materials.

Lahey, Crawford, and Hurlock (1976) developed a technique in which a skeleton strategy format could be used and different types of content could be entered in the format. The breakdown of content consisted of rules, examples, and practice problems with a provision for student selection of the content. Their project provided evidence that a type of skeleton format can save time in developing CAI learner control programs.

The rule-example-practice strategy was examined by Lahey and Coady (1978) at the Naval Research and Development Center. The purpose of the study was to investigate whether learner control of lesson strategy was superior to program control in computer based instruction. The subjects were 164 trainees at the Basic Electricity/Electronics School in San Diego. Three experimental conditions were established: full learner control, learner control with a provision for guidance, and program control. Guidance was provided by an advisor. The LC group had options on the selection, order, and amount of instructional content viewed. No significant differences in performance were reported.

The importance of this study to the present research is that
detailed records of student performance were kept during the study in order to provide a pattern from which to evaluate the student's learning strategies. The data identified the type of lesson content selected (rule, example, practice), the level of difficulty (easy, medium, hard), the number of helps accessed, the correctness of response to the practice questions, and the time lapse between successive choice responses.

Lahey and Coady (1978) reported that the most widely selected strategy was the rule-example-practice strategy. Guided LC students selected content in numerical sequence (80% of the time) more often than unguided LC students (59% of the time). Guided LC students also used the advised strategies (87% of the time) more often than unguided LC students (58% of the time). Yet, there were no significant differences in performance. It can be concluded that learner control options are effective when initiated independently by the learner.

Lahey examined this same event in 1978 in regard to guided instruction. Again, no significant differences were found. When the individual paths were analyzed, it was found that those learner control students who selected a rule-example-practice strategy performed better on three of the four tests, than those who did not. No investigation was made of the remaining LC students and why their paths were not effective.

Learners' strategies within instructional sequences have been examined in the learner control research. The learner's individual path through a computer assisted program has been recorded and analyzed (Newkirk, 1972). But this has definitely not occurred in any
systematic manner for each individual student.

There is some evidence that learners individually choose different paths in an instructional sequence when provided with control options. There has been no attempt to demonstrate that students learned to learn by controlling their own instruction. As Steinberg (1977) stated, "it is obvious that not all students are capable of making appropriate educational decisions" (p. 294). There is still much to be learned about learner control. The future of CAI depends on the development of sound instructional designs to be used in computer software.

Summary

The topic of the learner having an active role in his own learning has been presented in the review of the literature. The learner has had many different roles throughout various periods in the history of education.

In the traditional system of education, the emphasis was on the masses. Every learner studied a fixed curriculum of common branches of knowledge. The role of the learner was largely a passive one in which the instructor disseminated large bodies of information to the learner (Cronbach, 1978). Although differing learning abilities were recognized, these were viewed as permanent and stable. Some mastered the curriculum, others did not. Failure meant elimination from the system.

In the late 1950's and throughout the 1960's, the philosophy of education began to change. The traditional system was challenged.
During this period, individual differences among learners were slowly recognized and accepted (Musgrave, 1975). Several different methods of individualized instruction were offered as a solution for the inclusion of individual learners in the learning process. These approaches have been described in this chapter. Their contribution to the learner's role was a consideration of individual differences in the design and delivery of instruction.

Many of the early attempts to individualize instruction seem elementary to educators today. Learners were not offered many options in their learning; the main option afforded the learner was the pace of instruction. Yet, attempts to individualize instruction continued to be developed and studied when the technology and sophistication of computers reached the field of education.

During the 1960's, large scale computer programs which delivered instruction to learners were implemented across the nation in major university settings (Kulik, Kulik, & Cohen, 1980). But again, a common fixed curriculum or instructional program was available to the learner. The content was not only instructor determined, but program-controlled within the computer's software. The learner did receive individualized instruction via a computer terminal and at times, could control the pace of instruction, but he was not given a true active role.

At the same time, Mager and McCann (1961) focused their attention on an aspect of instruction later termed learner control. Although their work did not involve computers, learners were provided control over several components of instruction: delivery, pace,
content, and sequence. Mager's work demonstrated that learners differ in their choices about instruction and suggested that the base of knowledge of a given learner prior to instruction was a major determinant of these choices.

Learner control research continued through the 1970's, mainly due to the efforts of Wilson Judd and George Lahey. Judd and others were largely responsible for discussing the existing research on learner control, delineating the confusion among researchers in the field, and conducting initial studies using the computers with their definitions and specifications. Their studies afforded the learner control over: specific selections of course material (Judd, Bunder-son, & Bessent, 1970) and selection of test items, questions, practice problems, and drill problems (Judd, undated). It was concluded that learner control instruction was slightly significant over program-controlled instruction. Yet Judd stated that the research, in general, was quite inconclusive. He suggested the reason to be individual differences in student responses.

Lahey and his associates (1978) were the first to analyze individual learning strategies. The options available to the learner were rule, example, and practice materials. Although a dominant strategy was observed, no significant differences in performance between LC and machine-controlled sequences were found. The learner played an active role in his instruction and the effects were minimal.

In summarizing the review of the literature, the following points are germane to this study:
1. The utility of learner control options in an instructional program presented via a mainframe computer system has been demonstrated.

2. It has been demonstrated that learners make individually different selections when given control options in an instructional program.

3. A learner's base of knowledge, prior to instruction, may influence the learner's choice of control options.


5. A learner's pattern of LC strategies may have an effect on test performance on the instructional material.

6. It takes different amounts of time to use different patterns of LC strategies.

7. A group of learners may select a preferred learner control strategy.

8. A learner's preferred learner control strategy may become consistent over time.
CHAPTER III

DESIGN AND METHOD

This chapter focuses on the research design and methodology of the study. Presented are a review of the purpose of the study, the hypotheses explored, a description of the sample, a description of the instrumentation and procedures, and the procedures for data collection and analysis.

Purpose of the Study

The purpose of this study was to examine the following questions which were unique when compared to the previous body of learner control research: Do individual learners establish a discernible pattern of learner control strategies in the instructional program and what is the frequency of this pattern or its stability ratio?

If there is an identifiable pattern, is there a relationship between previous knowledge and experience in the content area, time taken to complete the instructional program, and test performance on the instructional content, and/or a relationship between these factors and the pattern selected by the learner and its concurrent stability ratio?

Hypotheses

The hypotheses and their rationale follow.

1. The group of learners will select different initial learner
control options in the instructional program.

Rationale: The conclusions reported by Mager and Clark (1969) suggest that learners will select individually different patterns of learner control strategies in an instructional program. It is assumed that the initial learner options selected by the learners will differ among the group of learners.

2. The learner control strategies of individuals will remain consistent throughout the entire instructional program; i.e., individual learners will exhibit a high stability ratio of LC strategies in the instructional program.

Rationale: Percentages of the times a preferred learner strategy was selected by a learner were provided by Lahey and Coady (1978). It appears that learners continue to select a preferred strategy instead of choosing another strategy at a later point in the instructional program.

3. The learners as a group will choose a preferred pattern of learner control strategies.

Rationale: There is evidence from several learner control studies to suggest that learners as a group will select a preferred pattern of learner strategies (Lahey, 1978; Lahey & Coady, 1978; Lahey, Crawford, & Hurlock, 1976). It is assumed, based on the work of Lahey and Coady (1978), that the individual learner will establish a discernible, preferred pattern of LC strategies. Several authors have suggested that learners are inclined to exhibit different learning styles (Briggs, 1971; Cole, 1978; Cross, 1978; Goldschmid & Goldschmid, 1976). These styles might be reflected in the selected
pattern of LC strategies.

4. The strength/weakness of a stability ratio of LC strategies will have a differential effect on the test performance of the learners.

Rationale: The studies conducted under the direction of Judd and Lahey furnished some support for the assumption that learners who select different patterns of learner strategies perform differently on examinations on the content material (Judd, Bunderson, & Bessent, 1970; Judd, Daubek, & O'Neil, 1975; Judd, O'Neil, & Spelt, 1974; Lahey & Coady, 1978; Lahey, Hurlock, & McCann, 1973). It must be remembered that the majority of these studies compared the learner control experimental group to a program controlled experimental group.

The present study examined the learners' stability ratio of LC strategies and its effect on test performance.

5. The time required to complete a pattern of learner control strategies will differentially affect the test performance of the learners.

Rationale: Lahey et al. (1973) analyzed the training time required to complete an instructional segment by learners selecting different patterns of learning strategies. It was suggested that there is a relationship between response time during the instructional program and test performance.

6. The learner's base of knowledge and experience will affect his/her choice of control options; that is, those with knowledge in the specific content area will not select as many control options as those without knowledge in the specific content area.
Rationale: After his learner control study, Mager (1961) advocated examining the relationship between a learner's base of knowledge and his/her selections in learner control research. It is assumed that a learner's depth of knowledge about a topic will affect his/her selections of control options.

7. The time taken to complete the instructional program will differentially affect the stability ratio of an individual learner.

Rationale: Since the previous research did not record the stability ratios of the learners, this hypothesis is not based upon previous research. Yet it is assumed that the time taken to complete the instructional program will have an effect on the magnitude of the stability ratio, those with a strong stability ratio will take less time to complete the program.

Instrumentation

Two instruments were developed for this study:

1. A screening instrument which was used for purposes of collecting demographic data and determining the learner's knowledge base in the specific content area and experience with microcomputers and;

2. A final examination used for testing the learner's knowledge of the material presented in the instructional CAI program.

The screening instrument was designed to collect the following demographic data:

1. A listing of the computer courses completed by the subject and the year in which they were completed. The subject was asked to list the names of any computer courses he/she had taken and the year
in which the course(s) was taken.

2. The present occupation of the subject. The subject was asked to indicate if he/she was currently studying to work in an educational field or was currently employed in an educational field.

3. The subject's hands-on experience with a computer. The subject was asked to indicate if he/she used a microcomputer in his/her occupation and if so, to check the categories of uses that applied from the following: CAI, CMI, word processing, and programming. A place for the subject to write in other uses was available. The subject was also asked to indicate if he/she owned a microcomputer.

The paper and pencil screening instrument also asked the subject to write down the time at which he/she began the CAI program. The subject was later asked, at the top of the final examination, to write down the time at which he/she finished the program. These were used to determine the length of time it took the subject to complete the program. See Appendix A for a sample of the screening instrument.

The final examination consisted of 20 statements to which the subject responded either true or false. Four questions were developed for each of the five units. See Appendix B for a sample of the final examination.

Field testing was used to determine if the program worked properly and if the screening instrument was suitable for the study.

Treatment

A CAI program was developed for purposes of this study. The content area of the program was assumed not to be critical to the main
purpose of this study. Since the researcher had focused on the uses of microcomputers in education in her doctoral studies and was employed as a Computer Specialist in the field of education, the specific content area selected for the microcomputer program was the uses of microcomputers in education. The program was developed to serve as an introduction for educators in this area.

The design of the program was adapted from a similar program format developed by Rosemary Newkirk (1972) at the University of Western Ontario to assist her in the study of learner control options. Her research compared the effectiveness of a learner control strategy to a machine control strategy. This study utilized learner control strategy components. A diagram of the design appears in Figure 1. A discussion of the diagram follows.

The instructional content of the computer program was divided into five instructional blocks, or units, with each unit dealing with a certain amount of newly introduced information, normally five main facts. Each instructional unit was comprised of five learner control options: (a) the lesson, (b) restatement of the lesson, (c) examples, (d) definitions, and (e) practice problems.

1. The Lesson - This was the main instructional component of the program. The lesson included the new information to be presented to the learners. Each lesson sequentially built on the previous lesson in terms of the content presented the learner.

2. Restatement - This instructional component repeated the ideas presented in the lesson and provided a more detailed explanation of the material.
Figure 1. Sequence of the Learner Control Options
3. Examples - The examples provided types of selections of the information presented in the lesson. They presented a portion of the lesson in a detailed manner to expand on the ideas contained in the lesson.

4. Practice Problems - The problems were intended as an opportunity to practice using the information presented in the lesson, or as a test of the student's understanding of the materials. If the student answered the practice problem incorrectly, a hint was given to the student prior to the opportunity to try and answer the problem again. If the student answered the problem incorrectly a second time, he/she was given the correct answer.

5. Definitions - These were available for all the technical terms presented in each lesson.

In the CAI program entitled "An Introduction to Microcomputers for Educators" the subjects first were presented a brief rationale on why the topic of computers for educators is important. The subjects then received an explanation of how the program would work. The program consisted of five units. The units were as follows:

1. The computer system
2. Software
3. Uses of computers in education
4. Computer literacy
5. Computer program

The subjects had five basic choices or options per each unit. The only requirement was that the subject view the lesson of each unit (option #6). The other options available to the subjects could
be selected at any point in time within each unit and repeated as often as they wished (options #1-5). These options were presented in a menu selection format that appeared on the screen after the completion of an option (Figure 2).

1. REDO THE LESSON
2. AN EXPLANATION OF THE LESSON
3. EXAMPLES
4. DEFINITIONS
5. PRACTICE PROBLEMS
6. THE NEXT LESSON

PLEASE ENTER THE CHOICE OF YOUR NEXT SELECTION: ___

Figure 2. Example of Option Selection Screen

The following table represents the number of screens or frames per option for the five units.

Table 1
Number of Screens Per Option

<table>
<thead>
<tr>
<th>Option</th>
<th>Number of Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lesson</td>
<td>9-10</td>
</tr>
<tr>
<td>An explanation of the lesson</td>
<td>4-5</td>
</tr>
<tr>
<td>Examples</td>
<td>2-4</td>
</tr>
<tr>
<td>Definitions</td>
<td>0-3</td>
</tr>
<tr>
<td>Practice problems</td>
<td>5</td>
</tr>
</tbody>
</table>

The number of practice problems for each unit was held constant at five. These were presented in a true/false format. The subject
had total control over the amount of time he/she needed to view each frame.

A basic content listing of each unit can be found in Appendix C.

A recording subroutine was built into the CAI program. This routine collected the options selected by each subject and stored these selections which were printed out and analyzed afterwards by the researcher.

Field Testing

Field testing was undertaken to determine if the program worked properly and if the screening instrument and final examination were suitable for the study.

The sample for the field testing consisted of 4 males and 16 females from several sites: (a) students enrolled in courses at Glen Oaks Community College in Centreville, Michigan; (b) educators and administrators employed at St. Joseph County Intermediate School District (ISD) in Centreville, Michigan during the summer of 1984; and (c) educators employed at Gillett Public Schools in Gillett, Wisconsin during the 1983-84 school year.

Table 2 presents the demographic data collected from the screening instrument.

Each subject volunteered to participate in the study after an initial contact by the researcher. All subjects followed the same procedures. The procedures appear below.

1. The subject was asked to complete the Pre-Program Survey.
2. The subject was then instructed to view the CAI program.
Table 2
Demographic Data on Subjects for the Field Testing

<table>
<thead>
<tr>
<th>Data</th>
<th>Positive Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used a microcomputer at work</td>
<td>8</td>
</tr>
<tr>
<td>Taken one computer course</td>
<td>10</td>
</tr>
<tr>
<td>Taken two or more computer classes</td>
<td>3</td>
</tr>
<tr>
<td>Never taken a computer course</td>
<td>7</td>
</tr>
<tr>
<td>Owned a microcomputer</td>
<td>1</td>
</tr>
</tbody>
</table>

At this time, subjects were told a final examination would be taken after they had completed the program.

3. When the subject reached the end of the program, he/she was instructed to get a copy of the final examination from the assistant present.

4. The subject completed the final examination.

5. The assistant collected all Pre-Program Surveys and final examinations. The program had recorded each subject's selections.

6. Each subject's file recorded by the program was printed and analyzed at a later time.

The results of the field testing showed that the CAI program and the recording portion of the program worked properly in an independent setting. No changes were made in this regard.

Modifications were made in both the screening instrument and the final examination. The screening instrument was determined to be lacking a question regarding the occupation of the subject. This was therefore added. In addition, question #4 which, if the subject owned
a computer, asked him/her to indicate the ways they used it, yielded answers that either were too vague (i.e., instruction) or could not be classified. Therefore, this section was revised with a list of uses from which the subject could select. A sample of the original screening instrument can be found in Appendix D.

The final examination was found to be too vague in several of the questions. Therefore, 8 out of the 20 questions were modified to further clarify the statements. Seven of the 20 were either dropped or changed into another statement regarding the same concept. Five questions remained the same. See Appendix E for a sample of the original final examination.

Study

The sample for the study consisted of 74 females and 24 males from the following sites: (a) undergraduate and graduate students enrolled at Western Michigan University during the Fall semester, 1984 and (b) educators employed in the eight local school districts in St. Joseph County during the 1983-84 school year. These districts include: Burr Oak, Centreville, Colon, Constantine, Mendon, Nottawa, Sturgis, Three Rivers, and White Pigeon. All of the subjects were volunteers except for 18 special education teachers attending a workshop at St. Joseph County ISD on October 18, 1984. The sample consisted of 98 subjects. Data from four subjects were deemed invalid due to a lacking of time scores.

Table 3 presents the additional demographic data collected on the subjects.
Table 3
Demographic Data on Subjects for the Study

1. 70 subjects were currently working in an educational field
   17 subjects were currently studying toward working in an
   educational field
   11 subjects did not complete this question

2. 51 subjects had never taken a computer course
   6 subjects had participated in a computer workshop
   17 subjects had taken one computer course
   24 subjects had taken two or more computer courses

3. 24 subjects indicated that they used a computer in their
   line of work
   In response to the uses of that computer:
   12 checked CAI
   6 checked CMI
   7 checked word processing
   10 checked programming
   5 wrote in specific other answers

4. 15 subjects indicated they owned a microcomputer

The procedures followed during the study were exactly the same
as those followed in the field testing.

Data Collection

The data were collected at two different times. Field test data
were collected during the summer of 1984. Data collection for the
study was on-going during the months of September through December,
1984.

All data collected had personal identifiers deleted and each
subject was assigned a number which was used during the data analyses.
Data Analyses

The hypotheses were tested with statistical procedures outlined in Hopkins and Glass (1978). All computer analyses were done using Western Michigan University's Computer Center's statistical package, STATPACK.

The statistical procedures for each of the seven hypotheses are as follows:

1. To determine if the group of learners selected different initial learner control options in the instructional program: Subjects were grouped into one of six groups representing their initial option choice. The comparison of frequencies were then analyzed using a 2x2 chi-square to determine whether the frequencies obtained were different from the frequencies that might be expected from chance variation alone.

2. To determine if the learner control strategies of an individual remained consistent throughout the instructional program: Frequency tables using the stability ratios were produced. A stability ratio was defined in Chapter I as the percentage of units in which the learner control strategies of the learner are exactly the same and is further explained in Chapter IV.

3. To determine if the learners as a group chose a preferred pattern of learner control strategies: Subjects were classified into sub-groups representing the ten most frequently selected LC strategies. Matrices were produced to show the LC strategies used as the subjects progressed from unit to unit.
4. To determine if the stability ratios of learner control strategies had a differential effect on the test performance of the learners: Each subject was counted as belonging to one of five stability ratio sub-groups depending on the number of units their learner control strategy was exactly the same. A one-way analysis of variance was then calculated using the frequencies of the five sub-groups to compare the mean test performance score of the five sub-groups.

5. To determine if there is a relationship between the time required to complete a pattern of learner control strategies and the test score: A Pearson Product-Moment Correlation was calculated using the time data and test score data to determine the predictability of one variable given the other variable.

6. To determine if the learner's base of knowledge and experience in the specific content area will affect his/her choice of control options: A t-test was calculated using the mean number of options chosen between two groups; those with knowledge and experience and those without.

7. To determine if the time taken to complete the instructional program affected the stability ratio of an individual learner: Subjects were divided into one of five sub-groups according to their stability ratios. The mean time numbers were compared among the five sub-groups through a one-way analysis of variance.

Alpha level .05, selected for this study, is typically a level set for educational research. Since the present study was a preliminary investigation, this level of significance was deemed appropriate for rejection of the null hypotheses.
Assumptions and Limitations of the Study

1. It was assumed that subjects responded accurately to all questions.
2. It was assumed that subjects accurately recorded the time it took them to complete the instructional program.
3. It was assumed that the pre-program questionnaire and the instructional CAI program were valid and reliable for purposes of the study.
4. Since the study was specifically limited to the variables and methods employed, the sample studied, and the findings drawn from the data, the results can only be generalized to similar populations.
5. The study was intended as an extension of the learner control research body and a foundation for further research.

Summary

This chapter offered a review of the purpose of the study and described the major components of the research design. The sample selection process, instrumentation development and procedures, and data collection and analyses were outlined in detail.

Findings of the study are presented in Chapter IV.
CHAPTER IV

REPORT OF THE FINDINGS

This chapter will report the results of the study, corresponding to the sequence of the hypotheses. A brief restatement of the purpose of the study follows.

Restatement of the Purpose of the Study

The purpose of this study was to investigate the effects of learner control options on several factors when presented in an instructional CAI program. These factors included:

1. A learner's initial learner control option selection in unit 1 of the instructional program.

2. The magnitude of the learner's stability ratio defined as the percentage of units in which a learner exhibited the same learner control strategy. A learner control strategy was defined as the sequence of learner control options selected by the learner in each unit.

3. The preferred learner control strategy, termed pattern, exhibited by the learners as a group.

4. The relationship between a learner's stability ratio and test performance on the instructional content presented in the CAI program.

5. The relationship between the time required to complete a pattern and the test performance on the instructional content.
6. The effect of a learner's prior knowledge and experience in the instructional content on the number of learner control options selected.

7. The relationship between an individual learner's stability ratio and the time taken to complete the instructional program.

Overview

Each learner completed an instructional CAI program containing five units. In each unit, the learner was presented with five learner control options. Options 1-5 could be viewed at any time, any number of times, or skipped. Selection (6), the next lesson, had to be chosen for each of the five units. The instructional program had a built-in recording routine which recorded each option in the order selected by the learner.

Seven hypotheses related to the factors mentioned above were addressed in this study. Where appropriate, the hypotheses have been stated in null form. The results for each are presented below.

Tests of the Hypotheses

Hypothesis 1

It was hypothesized that there would be no significant difference between the initial learner control options selected by the learners in the instructional program.

The initial learner control option was defined as the first learner control option selected in the first unit. The options
available to the learner were (a) redo the lesson, (b) restatement of
the lesson, (c) examples, (d) definitions, (e) practice problems, and
(f) the next lesson.

Frequencies and percentages describing the initial learner con-
trol option selection are shown in Table 4. The analyses resulted

Table 4
Frequencies and Percentages of Initial Learner Control Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Redo the lesson</td>
<td>2</td>
<td>2.04</td>
</tr>
<tr>
<td>(2) Restatement of the lesson</td>
<td>8</td>
<td>8.16</td>
</tr>
<tr>
<td>(3) Examples</td>
<td>18</td>
<td>18.37</td>
</tr>
<tr>
<td>(4) Definitions</td>
<td>3</td>
<td>3.06</td>
</tr>
<tr>
<td>(5) Practice problems</td>
<td>35</td>
<td>35.71</td>
</tr>
<tr>
<td>(6) The next lesson</td>
<td>32</td>
<td>32.66</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 64.00 \]
\[ df = 5 \]
\[ p < .05 \]

in a chi-square = 64.00 with 5 degrees of freedom. The probability of
a chi-square of this magnitude occurring by chance is below the .05
level. Hence the null hypothesis is rejected. There was a signifi-
cant difference in the observed proportions of initial learner con-
trol options chosen. As noted from the table, the majority of the
learners (68.4%) either selected the practice problems option or
proceeded to the next lesson without viewing any of the other options.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
**Hypothesis 2**

It was hypothesized that there would be no significant differences in the stability ratios of the LC strategies exhibited by the learners in the instructional program.

A stability ratio was defined as the percentage of units in which the individual learner control strategies were exactly the same. These data were represented as a ratio ranging from 1/5 through 5/5. A 4/5 stability ratio, for example, would describe a learner who selected the same options in the same order for four out of the five units. This ratio does not provide any information regarding the kind of options selected (examples, practice problems, etc.), but rather the consistency of the learner's LC strategy across all five units. The ratio also does not denote the units (1-5) for which the LC strategy remained exactly the same.

Frequencies and percentages were used to determine the proportions of stability ratios (1/5-5/5) within the group of subjects. These data are shown in Table 5.

The analyses resulted in a chi-square = 32.20 with 4 degrees of freedom. The probability of obtaining a chi-square of this magnitude by chance is below the .05 level. Hence the null hypothesis is rejected. There was a significant difference in the observed proportions of stability ratios. As noted, 34.7% of the subjects exhibited a 5/5 stability ratio, using the same LC strategy for all five units. An additional 31.6% exhibited a 4/5 ratio, using the same LC strategy for four of the five units. Therefore, the remaining 43.6% exhibited a 3/5 ratio or lower.
Table 5

Frequencies and Percentages of the Stability Ratios

<table>
<thead>
<tr>
<th>Stability Ratio</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5</td>
<td>5</td>
<td>5.10</td>
</tr>
<tr>
<td>2/5</td>
<td>11</td>
<td>11.22</td>
</tr>
<tr>
<td>3/5</td>
<td>17</td>
<td>17.35</td>
</tr>
<tr>
<td>4/5</td>
<td>31</td>
<td>31.63</td>
</tr>
<tr>
<td>5/5</td>
<td>34</td>
<td>34.70</td>
</tr>
<tr>
<td></td>
<td>98</td>
<td>100.00</td>
</tr>
</tbody>
</table>

χ² = 32.30
df = 4
p < .05

Hypothesis 3

It was hypothesized that the learners as a group would choose a preferred pattern of learner control strategies.

A pattern or a learner's preferred LC strategy was defined as the LC strategy most often selected by the learner when given control options in an instructional sequence. A learner control strategy, as previously defined, was the sequence of learner control options selected by a learner in each unit.

A LC strategy of 456, for example, would describe a situation in which the learner selected the definitions and practice problems for a particular unit prior to proceeding to the next unit. A number occurring twice describes a situation in which the learner viewed the same option twice for a particular unit.

It was determined that statistical analyses were not appropriate
for an interpretation of the data related to this hypothesis. In
order to maximize the information that could be drawn from the pat-
terns of LC strategies obtained from the built-in recording routine,
matrices representing the learners' choices from unit to unit were
constructed. The following procedures were used to address this
hypothesis.

1. Each LC strategy exhibited in unit 1 was listed and frequen-
cies of learners using that strategy in unit 1 were tabulated. See
Table 6 for these frequencies.

2. The nine highest frequency LC strategies were rank ordered
and assigned a letter (A-j) as their matrix labels to be used in the
matrices. The tenth matrix number was reserved for all other LC
strategies exhibited by the learners and labelled miscellaneous.
See Table 7 for the rank ordering of the LC strategies.

3. Matrices were constructed to display the LC strategies
exhibited by the learners from unit to unit (See Appendix F). A
10 by 10 matrix grid was used. Each cell represents the junction
of the LC strategies selected by the learner for the two instructional
units labelled. For example, a tally mark in the cell at the junc-
tion of (B) 56 and (E) 536 for units 1 and 2 would indicate a learner
who had exhibited the following LC strategies or choice sequences:
the learner selected (5) practice problems and (6) the next lesson in
unit 1 and (5) practice problems, (3) examples, and (6) the next les-
son in unit 2, in that order. The matrices show the progression for
units 1-5, two at a time. The percentages are included for each cell
containing at least one tally.
Table 6

Frequencies of LC Strategies Exhibited in Unit 1

<table>
<thead>
<tr>
<th>LC Strategy</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>56</td>
<td>25</td>
</tr>
<tr>
<td>3456</td>
<td>12</td>
</tr>
<tr>
<td>356</td>
<td>5</td>
</tr>
<tr>
<td>536</td>
<td>4</td>
</tr>
<tr>
<td>23456</td>
<td>3</td>
</tr>
<tr>
<td>546</td>
<td>3</td>
</tr>
<tr>
<td>456</td>
<td>2</td>
</tr>
<tr>
<td>234556</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>1346</td>
<td>1</td>
</tr>
<tr>
<td>123456</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>256</td>
<td>1</td>
</tr>
<tr>
<td>234456</td>
<td>1</td>
</tr>
<tr>
<td>23555556</td>
<td>1</td>
</tr>
<tr>
<td>36</td>
<td>1</td>
</tr>
<tr>
<td>3546</td>
<td>1</td>
</tr>
<tr>
<td>4556</td>
<td>1</td>
</tr>
<tr>
<td>526</td>
<td>1</td>
</tr>
<tr>
<td>556</td>
<td>1</td>
</tr>
<tr>
<td>5136</td>
<td>1</td>
</tr>
<tr>
<td>526</td>
<td>1</td>
</tr>
</tbody>
</table>

Key - Learner Control Options
(1) redo the lesson
(2) restatement of the lesson
(3) examples
(4) definitions
(5) practice problems
(6) the next lesson
A repeated number indicates a selection made more than once.
Table 7
Rank Ordering of Top Ten Strategies in Unit 1

<table>
<thead>
<tr>
<th>LC Strategy</th>
<th>Frequency</th>
<th>Rank Order</th>
<th>Alphabetic Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>33</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>56</td>
<td>25</td>
<td>2</td>
<td>B</td>
</tr>
<tr>
<td>3456</td>
<td>12</td>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td>356</td>
<td>5</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>536</td>
<td>4</td>
<td>5</td>
<td>E</td>
</tr>
<tr>
<td>23456</td>
<td>3</td>
<td>6.5</td>
<td>F</td>
</tr>
<tr>
<td>546</td>
<td>3</td>
<td>6.5</td>
<td>G</td>
</tr>
<tr>
<td>456</td>
<td>2</td>
<td>8.5</td>
<td>H</td>
</tr>
<tr>
<td>234556</td>
<td>2</td>
<td>8.5</td>
<td>I</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>-</td>
<td>10</td>
<td>MISC</td>
</tr>
</tbody>
</table>

Key - Learner Control Options
(1) redo the lesson
(2) restatement of the lesson
(3) examples
(4) definitions
(5) practice problems
(6) the next lesson
A repeated number indicates a selection made more than once.

A pattern, or preferred LC strategy, has been defined as the learner control strategy most often selected by the learner when given control options in an instructional program. Data from the matrices provide evidence that the learners as a group did select a preferred LC strategy (i.e., learners exhibited a pattern).

Learners as a group tended to select either the 56 pattern (selecting practice problems and the next lesson) or the 6 pattern (viewing all lessons without selecting any other LC options) with a stability ratio = 4/5 or 5/5. Table 8 summarizes the frequencies and percentages of the predominant LC strategies exhibited across units.
1-5. Complete LC strategies for units 1-5 are found in Appendix F.

Table 8
Summary of Most Predominant LC Strategies
Across Units 1-5

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
<th>Unit 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>29</td>
<td>42</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28.40%</td>
<td>1.96%</td>
<td>41.20%</td>
<td>2.94%</td>
<td></td>
</tr>
<tr>
<td>2.94%</td>
<td>15.68%</td>
<td>2.94%</td>
<td>23.52%</td>
<td></td>
</tr>
</tbody>
</table>

In interpreting this table, cells 6,6 and 56,56 represent a stability ratio = 5/5 and cells 6,56 and 56,6 represent a SR = 4/5. The data show that the learners tended to choose the 56 or 6 patterns with increasing frequency as they progressed from unit to unit. By the second unit, a majority of the learners were selecting the 56 or 6 pattern. It would appear that the learners used the first unit as an exploratory one prior to establishing a preferred LC strategy or pattern. This is further supported by comparing the total number of LC options selected per unit as shown in Table 9.

Evidence thus exists to support the research hypothesis that learners as a group will select a preferred LC strategy or pattern.
Hypothesis 4

It was hypothesized that there would be no relationship between the magnitude of the stability ratio of LC strategies and the test performance of the learner.

The learners were classified into five sub-groups representing their exhibited stability ratios. Sub-groups 1-5 represented stability ratios = 1/5-5/5 respectively. A one-way analysis of variance was performed to determine the significance of the differences between the five sub-groups and their test scores. The results of this analysis are shown in Table 10.

The observed F-ratio of .89 is not equal to nor greater than the critical F-ratio of 2.53 required at the .05 level, therefore, the null hypothesis is retained and the research hypothesis cannot be supported. A significant difference in test performance did not occur among the five stability ratio sub-groups.
### Table 10

**Analysis of Variance Stability Ratios and Test Performance**

<table>
<thead>
<tr>
<th>Stability Ratio Sub-Group</th>
<th>Size</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5</td>
<td>5</td>
<td>76.00</td>
<td>11.94</td>
</tr>
<tr>
<td>2/5</td>
<td>11</td>
<td>77.27</td>
<td>11.91</td>
</tr>
<tr>
<td>3/5</td>
<td>17</td>
<td>72.65</td>
<td>15.32</td>
</tr>
<tr>
<td>4/5</td>
<td>31</td>
<td>69.52</td>
<td>12.87</td>
</tr>
<tr>
<td>5/5</td>
<td>34</td>
<td>70.29</td>
<td>14.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Sq.</th>
<th>F</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>661.54</td>
<td>4</td>
<td>165.40</td>
<td>0.89</td>
<td>0.47</td>
</tr>
<tr>
<td>Within</td>
<td>17258.86</td>
<td>93</td>
<td>185.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17920.41</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hypothesis 5**

It was hypothesized that there would be no relationship between the time required to complete a pattern of LC strategies and the test performance of the learners.

A Pearson Product-Moment Correlation was used to determine if a relationship existed between time and test performance. Each subject's reported time taken to complete the program was matched with his/her test score on the final examination. Analyses yielded a correlation coefficient of -.30. The critical value of $r = .196$ at the .05 level, with an $N = 98$, is less than the absolute value of obtained $r$, therefore, the research hypothesis is tenable. However, the magnitude of the correlation obtained does not indicate a practical relationship between time and test performance in the context of this research.
Hypothesis 6

It was hypothesized that learners with knowledge and experience in the specific content area would select fewer learner control options than those without knowledge and experience in the content area.

Each subject was assigned to one of two groups: group 1 - those with prior knowledge and experience in the specific content area (microcomputers in general and/or in education) and group 2 - those without prior knowledge and experience in the content area, based on his/her responses to the pre-program questionnaire. Three questions on the questionnaire addressed this area. They were as follows:

1. List the names of any computer courses you have completed and the year you took them.
2. Do you use a microcomputer in your line of work?
3. Do you own a microcomputer?

If a subject listed any computer courses and/or answered affirmatively to questions 2 or 3, he/she was assigned to group 1. The opposite held true for assignment to group 2.

A t-test was performed on the mean number of learner control options selected by the two groups to determine if there was a significant difference. Table 11 presents the results of the analysis.

The t-ratio of 2.54, with 96 degrees of freedom, is greater than the critical t-ratio of 1.96 required at the .05 level. Therefore, the hypothesis, as stated, is rejected. However, the research hypothesis cannot be supported since the opposite occurred. Those with prior knowledge and experience in the specific content area selected more LC options than those without such knowledge and experience.
Hypothesis 7

It was hypothesized that there would be no relationship between the time taken to complete the instructional program and the magnitude of the stability ratio of LC strategies exhibited by the learners.

The subjects were classified into five sub-groups according to their stability ratio, ranging from 1/5-5/5. A one way analysis of variance was used to determine if there was difference between the five sub-groups on the time taken to complete the program. Table 12 reports the results.

The observed F-ratio (1.19) is not greater than the critical F-ratio of 2.53 at the .05 level, therefore, the null hypothesis is tenable. In this particular analysis, the times taken to complete the instructional program did not differ among the five sub-groups, therefore, the magnitude of the stability ratio had no significant effect on the time taken to complete the program.
Table 12

Analysis of Variance Stability Ratio and Time (in minutes)

<table>
<thead>
<tr>
<th>Stability Ratio Subgroup</th>
<th>Size</th>
<th>Mean Minutes</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5</td>
<td>5</td>
<td>35.20</td>
<td>4.55</td>
</tr>
<tr>
<td>2/5</td>
<td>11</td>
<td>34.09</td>
<td>7.91</td>
</tr>
<tr>
<td>3/5</td>
<td>17</td>
<td>34.82</td>
<td>12.81</td>
</tr>
<tr>
<td>4/5</td>
<td>31</td>
<td>32.35</td>
<td>11.60</td>
</tr>
<tr>
<td>5/5</td>
<td>34</td>
<td>28.97</td>
<td>10.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Sq.</th>
<th>F</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>550.49</td>
<td>4</td>
<td>137.60</td>
<td>1.19</td>
<td>0.32</td>
</tr>
<tr>
<td>Within</td>
<td>10744.25</td>
<td>93</td>
<td>115.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11294.75</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary

The above analyses revealed the following:

1. Learners selected significantly different initial learner control options.

2. The magnitude of the stability ratios was significantly different among the learners.

3. Learners as a group tended to choose a preferred pattern of learner control strategies.

4. There was no significant relationship between the magnitude of the stability ratio and the test performance of the learner.

5. There was a significant relationship between the time required to complete a pattern and the test performance of the learner. However, the magnitude of the relationship was sufficient for
practical purposes in the context of this research.

6. Learners with knowledge and experience in the specific content area selected more LC options than those without such knowledge and experience.

7. There was no significant relationship between the time taken to complete the instructional program and the magnitude of the stability ratio of LC strategies exhibited by the learners.

This chapter presented the results of the research by initially stating the hypotheses followed by corresponding analyses and discussion.

Chapter V presents the conclusions related to the data analyses in conjunction with related implications and recommendations.
CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS
AND RECOMMENDATIONS

This chapter presents a summary of the study including the findings, conclusions drawn from the findings, implications by the researcher to several applicable populations, and recommendations for future research.

Summary of the Study

The major purpose of this study was to investigate and collect detailed records of the LC strategies used when learners were presented with learner control options in a microcomputer program. The records were then used to categorize learners in several ways in an attempt to determine the relationship between their choices and time, test performance, and knowledge base.

A review of the literature briefly summarized past attempts at individualized instruction and then focused on a body of research which extensively addressed a topic called "learner control options". Judd (1972), the main researcher conducting these studies, called for additional research that would further identify individual differences. Absent from the previous studies was an attempt to collect detailed records of the learner's strategies or choices of instructional content in an instructional sequence. The microcomputer was recognized as having the ability to provide a vehicle for collecting these records.
Since the growing field of computer based instruction has begun to provide the learner greater autonomy in the learning process, this study attempted to once again focus the educational community's attention on learning styles and individual differences so that an impact on future educational practices in general and in computer-related areas might be achieved.

The sample included 98 adult learners involved in the fields of general and/or special education. Subjects first responded to a pre-treatment questionnaire to determine their previous knowledge and experience base in the area of computers. Subjects then completed a CAI microcomputer program entitled "An Introduction to Microcomputers for Educators" written by the researcher, consisting of five units of instruction. Within each unit learners were given control over the selection of six options: redo the lesson, restatement of the lesson, examples, definitions, practice problems, and the next lesson. Learners had complete control over the sequence and number of times an option could be viewed. The program recorded each selection made by the learner; this process was not evident to the user. Lastly, the subjects completed a 20 True-False question exam on the instructional material presented in the program. They also indicated the time it took them to complete the CAI program.

There were seven hypotheses tested:

1. The group of learners will select different initial learner control options in the instructional program.

2. The learner control strategies of individuals will remain consistent throughout the entire instructional program.
3. The learners as a group will choose a preferred pattern of learner control strategies.

4. The magnitude of a stability ratio of LC strategies will have a differential effect on the test performance of the learners.

5. The time taken to complete a pattern of learner control strategies will differentially affect the test performance of the learners.

6. Learners with knowledge and experience in a specific content area will select fewer learner control options than those without such knowledge and experience.

7. The time taken to complete an instructional program will differentially affect the magnitude of the stability ratio of LC strategies exhibited by the learners.

The findings of each of the above hypotheses are presented below.

Hypothesis 1 was tested by analyzing the initial learner control options selected by the learners in the instructional program. Frequencies and percentages of the six learner control options available to the learner were determined and a 2x2 chi-square was calculated. The findings of the analyses showed a significant difference between the six LC options initially selected by learners in the first unit. The majority of the learners (68%) either selected the practice problems option or proceeded to the next lesson without viewing any of the other options. Therefore, the hypothesis stating that there would be no significant difference was rejected.

Hypothesis 2 was tested by assigning each learner's LC strategies a stability ratio with a magnitude of between 1/5-5/5. Frequencies and percentages were used to determine the proportion of stability.
ratios (1/5-5/5) within the group of subjects. The findings of the chi-square showed a significant difference in the stability ratios exhibited by the learners in the instructional program. Therefore, the hypothesis stating that there would be no significant differences was rejected.

Hypothesis 3 examined the patterns chosen by the learners in the instructional program. This hypothesis was not statistically tested, rather matrices depicting the learners' LC strategies exhibited from unit to unit were constructed. Frequencies and percentages calculated for the top nine patterns revealed that by the second unit, a majority of learners were selecting the 56 (practice problems—the next lesson) or the 6 (viewing only the lessons without selecting any other options) patterns. It was concluded that evidence existed to support the research hypothesis.

Hypothesis 4 compared the relationship between the magnitude of the stability ratios of LC strategies and the test performance of the learners. An analysis of variance indicated no significant relationship between the two factors and, therefore, the null hypothesis was supported.

Hypothesis 5 compared the relationship between the time required to complete a pattern of LC strategies and the test performance of the learners. A Pearson Product-Moment Correlation coefficient was computed between the two variables. A significant negative relationship was found, therefore, the null hypothesis was rejected. However, the magnitude of the correlation obtained did not indicate a practical relationship between the two variables for purposes of drawing
any strong conclusions in this area.

Hypothesis 6 compared the number of LC options selected by learners with knowledge and experience in the specific content area of the instructional program to those without such knowledge and experience. The findings of the t-test showed a significant difference between the two groups, therefore, the null hypothesis was rejected. However, the research hypothesis could not be supported since the results were in a direction opposite to that hypothesized. Those with prior knowledge and experience in the specific content area selected more LC options than those without such knowledge and experience.

Hypothesis 7 compared the relationship between the time taken to complete the instructional program and the magnitude of the learners' stability ratio of LC strategies. A one-way analysis of variance indicated no significant difference between the magnitude of a stability ratio and the time taken to complete the program. The null hypothesis, as stated, was therefore tenable.

Conclusions

The following conclusions correspond to each hypothesis:

1. Learners differ in their initial learner control option selection. A majority of learners, but not all, in this study either selected the practice problems option or proceeded to the next lesson without viewing any of the other options. Options selected less often included: restatement of the lesson, examples, and definitions.
Although learner control research (Judd, Bunderson, & Bessent, 1970; Lahey & Coady, 1978; Mager & Clark, 1969) did not address the initial LC option selection, there was an indication that learners differ in their content selection. This assumption was supported by the present study.

2. Learners differ in the magnitude of their stability ratio of LC strategies. Learners differ in the number of times they select the same LC strategy (the same sequence of LC option selections) in an instructional program. A majority of learners established a stability ratio = 4/5 or 5/5. Still, a minority of learners did not exhibit a consistent LC strategy, switching the sequence of their selections from unit to unit. This supports Lahey and Coady's (1978) finding that learners continue to select a preferred strategy instead of choosing another strategy at a later point in an instructional program.

3. Learners differ in their choice of a preferred pattern. Although a majority of learners selected either a 56 (practice problem-next lesson) or a 6 pattern (viewing only the lessons without selecting any option), there are learners who deviate from these two patterns. This finding was in agreement with Lahey and Coady's (1978) study which indicated that although a majority of learners (56-87%) select a rule-example-practice strategy; a minority of learners did not exhibit this strategy.

4. There appears to be no relationship between the magnitude of a learner's stability ratio and his/her test score on an examination covering the material presented in an instructional program. The
number of times a learner selects the same LC strategy does not appear to influence the learner's test performance.

This conclusion concurred with the findings of Judd, Bunderson, and Bessent (1970) which indicated the provision of learner control over what material to view, the order, and the quantity of material did not have any significant effect on learner mastery. The previous study did not attempt to classify the LC strategies into sub-groups indicating the frequency of their occurrence.

5. There is some indication that there is a negative relationship between the time taken to complete a pattern of LC strategies and the test performance of learners. This differs from the research of Judd (undated) which suggested that LC students, when compared to program-controlled students, were not efficient in deciding the amount of practice needed to master instructional content. He found that the amount of practice did not significantly affect posttest scores.

6. Learners with prior knowledge and experience in a specific content area select more LC options in an instructional program than those without such knowledge and experience. This was consistent with Mager and Clark (1969) who suggested that the previous knowledge base of a learner in a specific content area was an important determinant of the sequence of instruction chosen by the learner.

7. There appears to be no relationship between the time taken to complete an instructional program and the magnitude of a learner's stability ratio. The time taken to complete the program does not vary significantly with stability ratios ranging from 1/5-5/5. Previous research did not specifically address this area.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
In addition to the above specific conclusions, the following general conclusions were drawn from the findings of this study.

Based on the findings that learners selected different initial learner control options in the first unit, it appears that learners used the first unit as a type of exploratory unit. This indicates that learners tried different options to examine the content of the option(s) and to determine their need for the option(s) or their desire to view these options in additional units.

The majority of learners selected the practice problems option only, without viewing any other options. It appears learners view additional material only if they feel that they need that material to pass an examination or master the material. This same conclusion can be drawn from the learners' preferred patterns of a 56 or 6 LC strategy sequence. A majority of learners tended to select only the practice problems as additional material to preview. Present instructional strategies used in education may be encouraging learners to approach learning with an "instruction - test" learning strategy.

A minority of learners did not exhibit any pattern. These learners might have adjusted their LC strategy to the specific content of each unit or, for reasons unknown, did not exhibit a preferred LC strategy.

Learners with prior knowledge and experience in the content area selected more options than those who lacked such knowledge and experience. This was contradictory to what was expected. This could indicate that learners may not be able to judge the value of their previous knowledge and experience in a content area in mastering a similar
area or that their interest in the topic influenced their desire to view additional material.

The time it takes a learner to complete an instructional sequence may be no indication of the learner's mastery of that material. It appears that learners vary in the time they need to master instructional content.

The number of times a learner's LC strategy is exactly the same from unit to unit does not appear to be related to the time it takes to complete an instructional sequence nor to the mastery of the instructional content. It is possible that some learners are not able to make option selections that provide them with the information necessary to master the material.

The general conclusion that can be drawn from this study is that adult learners tend to display similar learner control strategies.

Implications

The following implications, applicable to the field of education in general, can be formulated from the results of the study:

1. Instruction, presented in any format, for adult learners has historically and continues to be largely targeted for the mass of learners. Yet, a minority of learners differ in the way they choose to learn; therefore, instruction should address the needs of this minority.

2. Since adult learners may use learning strategies that do not lead to mastery of the material, instructors should provide varied presentation formats of instructional content.
3. Since adult learners tend to view only the material needed to pass an examination, if the intent of an instructional program is to focus beyond a minimum competency mastery level, instruction should provide incentives to the learner to explore additional material.

4. Since adult learners may not be able to judge the value of previous knowledge and experience in an area, instructors need to objectively measure a learner's present skills and knowledge in an area before assuming mastery in that area based on the learner's perception.

5. Adult learners vary in the time they need to master instructional content. Therefore, instruction should allow learners sufficient time to interact with and master the content.

The following implications address the area of computer-based instruction:

1. Authors of instructional content for computer-based materials or CAI programs should produce materials that allow for learners to use the first block of instruction as an exploratory unit. A practice unit to familiarize the learner to the types of presentation formats would allow the learner to concentrate on the content rather than on the presentation format.

2. Authors of CAI materials should provide learners control over the rate of presentation, type of presentation, mode of presentation, and the amount of instructional material to be viewed. This implies that varied presentation modes are provided from which the learner can select.

3. Authors of CAI materials should provide pre- and posttesting,
either built into the program itself or provided in a supplementary form, so that instructors can objectively measure the learners' mastery of the material.

4. Authors of CAI materials should provide built-in recording routines of student responses to add to the instructor's ability to analyze an individual student's learning style.

5. Authors of CAI materials should weigh the benefits of providing certain types of instructional choices to learners. Learners tend to choose practicing question/answer problems over viewing examples and definitions related to the instructional materials.

6. Educators using CAI should look for programs which, at a minimum, allow for posttesting to determine if the student has mastered the material presented.

7. Educators should select programs which allow for instructor decision and control in setting the level and pace of instruction and/or which automatically branch the student to instruction appropriate to his/her level of knowledge.

Recommendations

It is recommended that further studies be conducted in the area of learner control research, incorporating some of the changes in design suggested below:

1. Similar studies should be done to increase the generalizations that can be made in this area, using the following samples: (a) random sample of adult learners; (b) random sample of elementary school learners; and (c) random sample of handicapped learners.
2. Additional investigations should be conducted to determine if the patterns and stability ratios identified in this study are representative of the population of learners at large.

3. A study using different learner control options with varied presentation formats in a CAI program should be conducted to compare the patterns exhibited by learners to those identified by the present study.

The following general recommendations are applicable to both educators and authors of CAI materials:

1. Both groups named above should continue to be aware of current and future research which addresses the area of learner control.

2. Both groups should, whenever possible, contribute to this body of research, either by conducting in-classroom research using CAI materials or by pilot testing those CAI materials being produced to be used with learners.
APPENDIX A

PRE-PROGRAM QUESTIONNAIRE - STUDY
Pre-Program Questionnaire - Study

Name: ________________________________  Date: __________

Please answer all of the following questions.

1. List the names of any computer courses you have completed and the year you took them.
   Title: ______________________________ Year: ______
   Title: ______________________________ Year: ______
   Title: ______________________________ Year: ______

2. Are you studying to work in an educational field (teacher, administrator, etc.)?
   Yes __________  No __________

3. Are you presently working in an educational field?
   Yes __________  No __________

4. Do you use a microcomputer in your line of work?
   Yes __________  No __________

5. If yes to question #4, check the categories of use that apply to you.
   ______ CAI  ______ Word Processing
   ______ CMI  ______ Programming
   ______ Other ______________________________________

6. Do you own a microcomputer? Yes ______  No __________

Thank you for your assistance with this questionnaire.

What time is it now? _____________

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Posttest to the Program - Study

Please put down that time it is now, so I can tell how long it took you to go through the program: __________________________

Please answer "T" for True or "F" for False to all of the following questions.

1. Programming courses in public education usually teach Basic.
2. The formatting process divides a diskette into tracks and sectors.
3. Every computer has a CPU.
4. Drill and practice programs are the most common form of CMI programs.
5. A computer with at least 64K RAM is recommended for school use.
6. You need to know Basic in order to use most authoring programs.
7. In general, software are not interchangeable between computers.
8. It is illegal to make a back-up copy of copyprotected software that does not come with a back-up.
9. Never place a diskette near a magnetic surface.
10. The biggest obstacle to implementing computer courses is teacher training.
11. In general, computer literacy refers to being able to read software documentation.
12. Teacher utilities are programs that enable the computer to carry out functions related to teacher responsibilities.
13. A lab setting is usually desirable at the junior/senior high level.
14. CMI programs are written for the majority of students.
15. Initializing a diskette means to label the diskette so that you don't forget what is on it.
16. In general, the educational community agrees on how computers should be used in education.
17. Public domain software refers to those programs produced by a public agency.
18. A functional computer system is one with an input, processing, and output device.
19. Data in RAM are erased when the computer is turned off.
20. CAI stands for computer analyzed instruction.

Thank you for your participation.

I hope the program was helpful to you.
APPENDIX C

SUMMARY OF CAI PROGRAM CONTENT
Summary of CAI Program Content

Unit #1: The Computer System

The main objective of this lesson was to familiarize the learner with the minimal components of a functional computer system.

The lesson included the following content material:
1. The input-processing-output structure of a computer system.
2. Different types of input and output devices.
3. Differences between microcomputers such as: location and types of keyboards and monitors.
4. Explanation of the functioning of a disk drive and a cassette recorder.
5. Memory requirements and its connection to software.
6. Uses of a printer.
7. Comparison of a calculator to a microcomputer.

Unit #2: Software

The main objective of this lesson was to acquaint the learner with the types and sources of software used in education, how programs are stored on disks, software evaluation, and a brief discussion of the use of backups.

The lesson included the following content material:
1. Explanation of software and programs and the uses of these terms.
2. Discussion of how a computer needs instructions to work.
3. The use of floppy disks, their size, their compatibility between different brand names of computers.
4. Initializing a disk and saving information to a disk.
5. Do's and don'ts in caring for disks.
6. Differences between public domain and commercially produced software.

7. The law regarding the use of backups.

8. Preview and software evaluation.

9. Instructional design and educational software.

10. Sources of software.

11. Sources of software evaluations.

Unit #3: Uses of Computers in Education

The main objective of this lesson was to provide the learner with a brief explanation of computer-assisted instruction, computer-managed instruction, teacher utilities, administrative uses, programming, and computer literacy.

The lesson included the following content material:

1. Types of computer assisted instruction programs.

2. Uses of computer managed instruction such as record keeping and testing.

3. Examples of teacher utilities.

4. Examples of administrative uses of computers in the school office.

5. The content of high school programming courses.

6. Meanings of computer literacy.

7. Capabilities/limitations of each use.

8. Costs of administrative packages.

Unit #4: Computer Literacy

The main objective of this lesson was to allow the learner to preview a listing of educational objectives for a computer literacy course.
The lesson included the following content material:

1. The responsibility of K-12 education to produce computer literate students.

2. The listing of educational objectives included:
   a. An explanation of computer literacy.
   b. Personal perceptions about computers.
   c. History of computers.
   d. Differences in computers and their use.
   e. The effect of computers on the job market.
   f. The effect of computers on society.

3. The need for teacher training.

4. The skills of a computer literate person.

5. Suggested sample activities for a computer literacy course.

Unit #5: Computer Programs

The main objective of this lesson was to explain uses of the computer in the classroom compared to a lab setting.

The lesson included the following content material:

1. Considerations for selection of hardware.

2. Development of computer curriculum objectives.

3. Responsibilities and structure of a computer committee.

4. Considerations in offering inservice training.

5. Considerations in the location of computers.

6. Pros/cons of a lab setting versus one computer per classroom.

7. Questions to ask school districts who already have computer programs.

8. Balance of objectives within the computer curriculum.

9. Balance of computer curriculum with the regular education curriculum.

10. Sources of guides/books addressing the topic of computer curriculum development.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
APPENDIX D

PRE-PROGRAM QUESTIONNAIRE - FIELD TESTING
Pre-Program Survey - Field Testing

Name: _______________________________ Date: _________________

Please answer the following questions:

1. Do you own a microcomputer?
   Yes ____________ No ____________

2. Have you taken a computer course?
   ____ 1 course ____ 2 courses ____ 2 or more courses
   ____ no

3. Have you ever used a computer?
   Yes ____________ No ____________

4. If you have used a computer, please briefly state what for and what period of time.
   Purpose: _______________________________________
   Length of time: _________________________________
APPENDIX E

FINAL EXAMINATION - FIELD TESTING
Post Program Test - Field Testing

Name: ___________________________ Date: ____________

Please answer the following statements using T for True and F for False.

___ 1. Software programs are interchangeable between computers.
___ 2. The biggest obstacle to implementing computer courses is teacher training.
___ 3. CMI programs are those written for the majority of students.
___ 4. Software is considered public domain if it is produced by a public agency.
___ 5. You should look for educational software that allows you to alter its speed, sound, etc.
___ 6. Every computer has a central processing unit.
___ 7. Tutorials are the most common form of CAI programs.
___ 8. It is illegal to make a back-up copy of copy protected software.
___ 9. Computer literacy refers to being able to read software documentation.
___ 10. A computer's useable memory or RAM is measured in kilobytes or K.
___ 11. You need to know the Basic language in order to use most authoring programs.
___ 12. A computer needs some type of storage unit to be considered functional.
___ 13. Initializing a diskette means to label the diskette so that you don't forget what is on it.
___ 15. The amount of memory a computer has affects the size of the program and the amount of information that can be inputted.
___ 16. How computers work is a part of a computer literacy course.
___ 17. Pressure or bending a diskette cannot harm its surface since it is made of a mylar surface.
18. A lab setting of computers is usually desirable at the Junior/Senior High level.

19. A floppy diskette is called software because it is bendable.

20. There seems to be a trend away from a heavy emphasis in teaching programming toward teaching applications of a computer.
APPENDIX F

MATRICES OF PATTERNS OF LC STRATEGIES
UNITS 1-5
Matrix Table of LC Strategies for Units 1 and 2

<table>
<thead>
<tr>
<th>UNIT 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>29</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>28.4</td>
<td>1.96</td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2.94</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>4.90</td>
<td>2.94</td>
<td>.98</td>
<td>2.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1.96</td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>2.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1</td>
<td>.98</td>
<td>1</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>1</td>
<td></td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>7</td>
<td>3</td>
<td>6.86</td>
<td>2.94</td>
<td>3</td>
<td>2.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: LC Strategies
(A) 6
(B) 56
(C) 3456
(D) 356
(E) 536
(F) 23456
(G) 546
(H) 456
(I) 23456
(J) Miscellaneous

Key: LC Options
(1) redo the lesson
(2) restatement of the lesson
(3) examples
(4) definitions
(5) practice problems
(6) the next lesson

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Matrix Table of LC Strategies for Units 2 and 3

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>42</td>
<td>3</td>
<td>41.2</td>
<td>2.94</td>
<td>3</td>
<td>2.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>24</td>
<td>2.94</td>
<td>23.52</td>
<td>2</td>
<td>3</td>
<td>1.96</td>
<td>2.94</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>1</td>
<td>.98</td>
<td>.98</td>
<td>1</td>
<td></td>
<td>.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>1</td>
<td>.98</td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UNIT 3

<table>
<thead>
<tr>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>23456</td>
<td>546</td>
<td>456</td>
<td>234556</td>
<td>Miscellaneous</td>
</tr>
</tbody>
</table>

Key: LC Strategies

(A) 6
(B) 56
(C) 3456
(D) 356
(E) 536
(F) 23456
(G) 546
(H) 456
(I) 234556
(J) Miscellaneous

Key: LC Options

(1) redo the lesson
(2) restatement of the lesson
(3) examples
(4) definitions
(5) practice problems
(6) the next lesson

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Matrix Table of LC Strategies for Units 3 and 4

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>49</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>48.03</td>
<td>1.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>23</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.88</td>
<td>23.54</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.98</td>
<td>6.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: LC Strategies
(A) 6
(B) 56
(C) 3456
(D) 356
(E) 536
(F) 23456
(G) 546
(H) 456
(I) 234556
(J) Miscellaneous

Key: LC Options
(1) redo the lesson
(2) restatement of the lesson
(3) examples
(4) definitions
(5) practice problems
(6) the next lesson

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
### Matrix Table of LC Strategies for Units 4 and 5

#### UNIT 4

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>2</td>
<td>1</td>
<td>27</td>
<td>1</td>
<td>1.96</td>
<td>26.47</td>
<td>.98</td>
<td>3.92</td>
<td>.98</td>
</tr>
<tr>
<td>53.92</td>
<td>1.96</td>
<td>2</td>
<td>1.96</td>
<td>1</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### UNIT 5

<table>
<thead>
<tr>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>.98</td>
<td></td>
</tr>
<tr>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Key: LC Strategies
- (A) 6
- (B) 56
- (C) 3456
- (D) 356
- (E) 536
- (F) 23456
- (G) 546
- (H) 456
- (I) 234556
- (J) Miscellaneous

#### Key: LC Options
- (1) redo the lesson
- (2) restatement of the lesson
- (3) examples
- (4) definitions
- (5) practice problems
- (6) the next lesson

---

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
BIBLIOGRAPHY


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.


Judd, W. A. (undated). Program vs. learner control of selection of instruction and amount of practice in computer-assisted instruction. Austin, TX: The University of Texas. (ERIC Document Reproduction Service No. ED 064 399)


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.