DOCUMENT RESUME

ED 125 543 IR 003 627

AUTHOR	Lahey, George F.; And Others
TITLE	Learner Control of Lesson Strategy: A Model for PLATO IV System Lessons. Technical Report, November 1973 to June 1975. Final Report.
INSTITUTION	Navy Personnel Research and Development Center, San Diego, Calif.
REPORT NO	NPRDC-TR-76-36
PUB DATE	Jun 76
NOTE	20p.
EDRS PRICE	MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; Computer Graphics; Computer Oriented Programs; Educational Research; Individualized Instruction; *Instructional Improvement; Instructional Materials; Instructional Systems; Learning Theories; *Locus of Control; Military Training; *Models; On Line Systems; *Time Factors (Learning)
IDENTIFIERS	Authoring; *Learner Controlled Instruction; Navy; PLATO IV; Programmed Logic for Automatic Teaching Operations

ABSTRACT

A technique was developed to facilitate creating computer-based instruction (CBI) with a minimum of effort on the part of the author/coder, and the feasibility of using a structure which puts control of the lesson strategy into the hands of the student learner was investigated. A model which relieves the author of CBI strategy selection was developed for the PLATO IV system and was tested in two instructional situations: training students to use a multimeter to measure resistance and current flow, and assisting Navy mess management specialists in recipe conversion. Student performance using the learner control mode was compared to that of other students using the regular CBI method. Students using the learner control mode experienced a savings in training time, and the use of an authoring aid was shown to save time over other methods of lesson preparation. (CH)

NPRDC TR 76-36 June 1976

ED125543

LEARNER CONTROL OF LESSON STRATEGY: A MODEL FOR PLATO IV SYSTEM LESSONS

George F. Lahey
Alice M. Crawford
Richard E. Hurlock

Reviewed by
John D. Ford, Jr.

Approved by
James J. Regan
Technical Director

Navy Personnel Research and Development Center
San Diego, California 92152

IR003627

FOREWORD

The research and development described herein was performed under Technical Development Plan 43-03 (Education and Training Development), Work Unit 43-03.03A, (Experimental Evaluation of PLATO IV Technology). This effort is part of an Advanced Research Projects Agency/Joint Services Training Technology Program for development of computer-based training technology.

The cooperation and assistance of the following are gratefully acknowledged. Personnel at the Basic Electricity/Electronics School and Mess Management Specialists School, Service School Command, Naval Training Center (NTC), San Diego, provided students for the test of the format described herein. Mr. P. H. Elliott provided valuable feedback from his experience with a metric conversion lesson. Ms. P. S. Fredericks and Mr. L. Hoover-Rice provided valuable data on their experience with students from the Mess Management Specialists School. Ms. Betty Whitehill assisted the authors during student runs.

JAMES J. CLARKIN
Commanding Officer

SUMMARY

Problem

Preparation of lesson materials for computer-based instruction is a time-consuming task requiring special skills. Authors must usually develop the lesson materials, develop an overall strategy, develop criteria for mastery of individual lesson segments, etc. One way to reduce this workload and make lesson preparation less costly and time-consuming would be to develop authoring aids, such as an instructional strategy which could be applied universally, irrespective of subject matter. This strategy might then be preprogrammed and packaged as a "driver" available for general use. The driver would provide the branching, routing and record-keeping functions necessary to lesson presentation. Authors of CBI lessons could then concentrate on preparation of content compatible with the nature of the driver.

Objectives

The objectives of this research were to develop a technique to facilitate creating computer-based instruction (CBI) with a minimum of effort on the part of the author/coder, and to investigate the feasibility of, for this purpose, using a structure which puts control of lesson strategy into the hands of the student learner.

Approach

The essential aspects of a learner control lesson were seen to be apropos to development of a driver. The breakdown of content into rules, examples, and practice problems for each objective, with provisions for student selection of the basis of type of content, relieves the author of strategy selection. A model using this format was developed for use on the PLATO IV system. The utility of the model was then tested by preparing instruction in two different application areas, use of a multimeter to measure resistance and current flow, and recipe conversion for mess management specialists. These lessons were then tested using students for whom these materials were essential parts of their school instruction. Their performance was observed and compared to that of other students using their regular mode of instruction.

Results

The utility of the model was demonstrated by having authors prepare lessons which made considerable demands on the model structure. Two of the authors so involved had minimal exposure to the development of the model and to authoring on the PLATO IV system. Students using these instructional lessons were compared to those using their regular modes of instruction. Their test performance did not differ significantly. Moreover, the students using the learner control mode of instruction appeared to be highly motivated and generaly enthusiastic about their experience. In the case where computer-based instruction was compared to classroom instruction they experienced a very considerable savings in training time.

The time required to develop the lessons for mess management specialists were found to be significantly less per hour of instruction time than the time required by other authors preparing CBI lessons of comparable difficulty.

Conclusions

This project demonstrated that the use of an authoring aid can indeed save time over other methods of lesson preparation for the author of computer-based instruction. The use of a "universal" driver to control lesson strategy eliminated a major part of the task of lesson preparation, offering a significant savings in both author training and lesson preparation time.

CONTENTS

FIGURES

INTRODUCTION

Problem

Preparation of lesson materials for computer-based instruction (CBI) is a time-consuming task requiring special skills. Several elements are involved. Authors must decide on a lesson strategy, prepare the subject material to fit the strategy, develop mastery criteria, develop the coding, debug the lesson from both a strategy and content standpoint, try it out on students, and finally revise the strategy and content based on experience with the lesson. One way to reduce this workload and make lesson preparation less costly and time-consuming would be to develop authoring aids, such as an instructional strategy which could be applied universally, irrespective of subject matter. This strategy might then be preprogrammed and packaged as a "driver" available for general use. The driver would provide the branching, routing, and record-keeping functions necessary to lesson presentation. Authors of CBI lessons could then concentrate on preparation of content compatible with the nature of the driver.

Objective

Learner control, which puts lesson strategy in the hands of the student, is particularly apropos to the development of a driver and is of intense interest as a method of instruction. The major requirement of the driver is to be responsive to the student's choices. The student must select his own instructional path or strategy and decide when he has achieved mastery. The author's responsibility becomes one of preparing adequately instructive content in a form compatible with the driver function.

The objectives of this research, then were to develop a technique to facilitate creating computer-based instruction (CBI) with a minimum of effort on the part of the author/coder, and to investigate the feasibility of using a structure which puts control of lesson strategy into the hands of the student learner.

Background

The hypothesis that learners should be given control of lesson strategy traces its origins to experiments conducted by Mager and his associates in the early 1960s (Mager, 1961; Mager & McCann, 1961; Mager & Clark, 1963). Their findings indicated that students given complete control of lesson strategy not only had a better learning experience but also completed training in a shorter time than students whose learning was controlled by teachers. At about the same time, Evans, Glaser, and Homme (1960) presented researchers with a conundrum which remains unsolved at this writing: What should be presented first, rules or examples?

Gagne' (1970) proposed that lesson materials be presented according to rather rigid hierarchical constructs. His theorems require that authors analyze the relationships of the lesson objectives, asking themselves what the learner must know in order to achieve this new task given instruction only. Further, his theorems require materials within objectives to be presented so that the student can first make associations, then discriminations, and finally recognize the rule(s) governing the construct being presented. Gagne' agrees with other authors (e.g., Stolurow, 1955) that lesson materials should be adaptive; that is, they should move to the next logical step as soon as the learner has demonstrated mastery. However, such advances would presumably be controlled by the author on the basis of criterion testing rather than by the student.

One point that Gagne' makes quite strongly is that learning depends upon events in the learner's external environment. Since these events cannot necessarily be controlled by either the student or the teacher, the question that arises is whether the student who experiences them or the teacher who presumes them is better able to assess them.

Perhaps the most persuasive literature on the subject of learner control is that prepared by Merrill and his associates (Merrill, 1973; Merrill & Boutwell, 1973). Merrill (1973) stated that strategy and content are independent, at least to the extent that what is to be taught is independent of how it is to be taught. If, then, one were to provide a standardized strategy or strategies which would have wide, perhaps universal application, the task of the individual author could be reduced to developing, encoding, debugging, and revising content only, a considerable saving over the full task. One such strategy is offered by Merrill. Giving control of lesson strategy to the student is an instructional device which relieves the author of concern for strategy, and permits development of a lesson model in which the author's sole concern is in developing the appropriate content.

The Merrill papers were based largely on theoretical constructs, which formed the theoretical basis for the development of the Time-Shared Interactive Computer Controlled Instructional Television (TICCIT) system. This system is being used operationally at Northern Virginia Community College, Phoenix Junior College, North Island Naval Air Station at San Diego, and Brigham Young University.

In a comprehensive review of previous research on learner control, Judd, O'Neil, and Spelt (1974) raised serious questions about the methods used and the influence of uncontrolled variables. They stated further that learner control can mean very different things to different people. Even the TICCIT system puts many restrictions on the learner, such as prerequisite lesson objectives and prerequisite criteria for content selection. However, in spite of their objections, there appears to be a wealth of research indicating some advantage for learner control, at least from a motivational, if not a performance, standpoint.

Research on learner control originated at the Naval Personnel and Training Research Laboratory (NPTRL), San Diego in the early 1960s. (NPTRL and the Naval Personnel Research and Development Laboratory, Washington were merged in 1973 to form the Navy Personnel Research and Development Center). Initial efforts were directed at adaptive as opposed to linear programming, but adaptive only to the extent that students were branched past linearly programmed materials as soon as they demonstrated mastery. Later research (Slough, Ellis, & Lahey, 1972; Hurlock, 1972; McCann, Lahey, & Hurlock, 1973) gave students more control, reflecting increased awareness of the advantage of student participation in selection of materials.

PROCEDURE

Late in 1973, a beginning was made on a learner control model along lines largely consistent with Merrill's propositions. The following prescriptions were adhered to in developing this model:

1. The student should have complete control of the order in which he selects the lesson segments or objectives.

2. Having selected an objective to study, the student should have complete freedom of choice of type of content (i.e., rules, examples, and practice problems) for that objective.

3. Having selected a type of content, the student should have complete freedom of choice as to the level of difficulty (easy, medium, or hard) of the materials presented.

4. The final lesson segment, the lesson quiz, should be available as an option. That is, the student should be able to take it at any time, omit it if he chooses, or repeat it if desired.

A skeleton strategy (driver) and content sections were developed for delivering lessons on the PLATO IV System. This system, an interactive, general-purpose system as described by Bitzer & Johnson (1971), is flexible and fairly easily programmed, offering authors the opportunity to create materials with few prerequisite constraints. A photo of a PLATO IV terminal is presented as Figure 1. Using a dummy lesson, the paradigm was examined for its utility and feasibility.

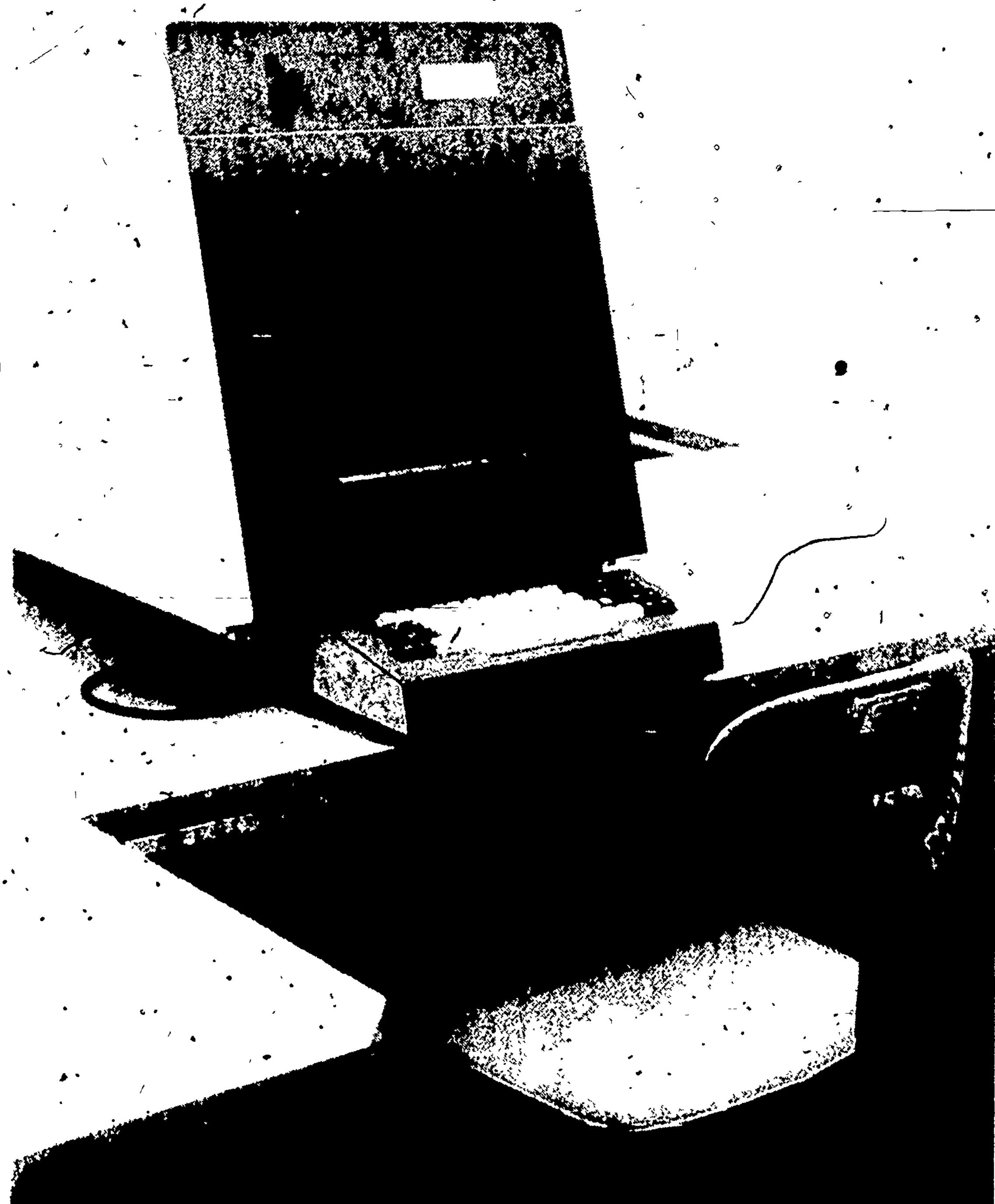

Figure 1. Student terminal.

RESULTS

The original model clearly indicated that preparing separate strategy and content sections for a CBI lesson was feasible for the PLATO IV System. The strategy section was reasonably economical, in terms of both the amount of computer storage required and the rapid, cogent response to learner selection of content.

During 1974, the model was used to prepare lessons in two fields: (1) using a multimeter to measure electrical resistance and current flow, and (2) using the mathematics of converting standardized Navy recipes to fit messes of widely different sizes. The multimeter lessons became the primary development vehicle and exposed several weaknesses in the original model which required changes in the driver and content formats. The recipe conversion lessons, which were developed later by authors who had had no previous experience with the model, also exposed some weaknesses. Thus, during the course of lesson development, the model underwent significant changes, although the basic paradigm remained the same.

Initial tryouts indicated that students did not appreciate or understand the options available. Thus, revisions were made to the introduction and to the form of the presentations used. Even during the research effort which followed, when many students (74 multimeter students, 40 recipe conversion students) were using the lessons, some shortcomings in the driver were evident and minor adjustments were required. However, results of these efforts, as reported by Lahey, Crawford, & Hurlock, 1975; and Fredericks, & Hoover-Rice, in press, indicate that authors are able to develop meaningful lesson materials in the form required by the model. Further, for both types of subject matter, learner control of lesson strategy proved to be an effective mode of computer-based instruction.

In the multimeter study, there was no significant difference in performance on laboratory tests and module examinations between students taking the multimeter lessons via CBI and others using regular individualized instruction techniques. The CBI students took longer to finish the modules than the regular students, partly because of the time required to get acquainted with the new training mode, and partly due to increased opportunity for (simulated) practice.

In the recipe conversion study, experimental (CBI) students with 4 hours of instruction scored as well on final examinations as controls who received 28 hours of classroom instruction. This represented a highly significant savings in training time. It is also important to note that this test population included a large proportion of below average aptitude trainees. As to the author requirements for lesson preparation, Fredericks and Hoover-Rice were able to prepare their lesson materials with a minimum of guidance from the model developers, and to complete their lesson materials in less time than was required by authors using more conventional techniques (77 hours per hour of instruction as opposed to 315 hours per hour).

The final version of the model, which was developed upon the conclusion of these research efforts in January of 1975, is described in the following section.

LEARNER CONTROL MODEL

Basic Premises

The major premise used in developing the learner control model was that lesson content and lesson strategy are independent functions, so that a common instructional strategy can be used to present CBI lesson materials for a wide, perhaps limitless, variety of subject matters. This common instructional strategy, which would include all control and record-keeping functions, would allow the author to concentrate on the development of instructional content.

Minor premises were:

1. Once the lesson content had been prepared, encoding the lesson should not require intimate knowledge of the computer language but only the basic ability to edit code, in this instance the TUTOR language.

2. Authors using the model for development of their own lessons should learn the operations required (excepting, of course, how to edit the TUTOR language) from content within the model rather than having to look to an external source.

Format

The strategy section of the lesson is segregated within three blocks of the model, which are identified as the "driver." All units essential to controlling lesson strategies are contained in these three blocks, including those for the basic branching and record-keeping functions, and for accessing units of the content section. To accomplish this latter function, the basic units within the content section have specified labels.

Lesson materials consist of three types of content (rules, examples, and practice problems) at three levels of difficulty (easy, medium, and hard); see Figure 2. The medium level of difficulty is aimed at the "average" student; easy, at those having trouble with medium level materials; and hard, at those ready for an approach involving the use of technical terms. The hard level is frequently omitted.

The model format calls for rules to be subsumed within single units for each level of difficulty. Thus, Unit "ezru" contains the easy-to-read rules; Unit "medru," the medium rules; and Unit "hdru," the rules involving technical terms. On the other hand, because each example set may include many examples, examples for each level of difficulty are subsumed within a single unit. Thus, the easy examples for Objective 1 are subsumed within Unit "ezinl,"; medium examples, within Unit "inl,"; and hard examples, within Unit "hdinl."

An introduction used to indoctrinate students occupies the initial blocks of the model lesson. It tells the student what to expect and how to use the model and is as instructive to new authors as it is to students. In instructional lessons, the introduction should not be physically located in the author's base lesson. It will usually be put elsewhere, followed by a jumpout to the base lesson.

The last part of the model contains special units used to demonstrate special features and to display the paths students take through their lessons. Most lessons will be similarly constructed, in that authors will add special units to provide graphics and other illustrative presentations to supplement the text contained in the basic content units, and to see what students actually do in using their lessons.

Functional Characteristics

Access to Content

Access to content is controlled by two key units which direct the student's responses and accept his choice of materials. One unit lets him choose an objective from an index of the subject matter, (Figure 3) the second shows which key to press for the various types of content.

The student accesses the various types of content via touch panel or keypress. A table of key functions (presented at the bottom of the plasma-screen) is displayed at all times except when the student is referring to the index page or answering a problem. As shown in Figure 4, it offers the student his choice of rule, example, or practice; easy, medium, or hard versions of each; and helps and superhelps. The student can either press the key indicated (see keyboard, Figure 5), or touch the block on the screen with identifies the key function. Both options are available at all times during the lesson.

Selection of Type of Content and Level of Difficulty

After the student has selected the subject he wants to study from the index page, he is branched to an expanded statement of the learning objective. When properly worded, the statement is a behavioral description of what he will be able to do upon completing the study of that lesson segment. From the objective "page," the student chooses a content category; i.e., rule, example, or practice (see Figure 6). Upon selecting the desired category of content, the student is presented with an item at the medium level of difficulty. He can then change the level of difficulty to easy or hard or back to medium as he desires.

Access of Special Units

Special units are used to expand the capabilities of the model. Whereas the basic content units have specified labels and a -writec- format, special units may have any format and label the author desires. The branching commands required to access special units are placed within content units. The driver handles their accession by accessing the content unit. Using special units, authors conversant with TUTOR coding can create lessons to fit almost any instructional requirement.

Instance Sequencing

Since examples and practice problems differ only as to their expository/inquisitory nature, the facts pertaining to a particular instance may often be used in either form. The model therefore calls for a file of instances to serve both as examples and practice problems. Access to individual instances is controlled by indexing a counter. All files recycle (return to the first instance) after presenting the last instance.

Answer Processing

A five-part, multiple-choice format has been chosen as a standard format for practice problems. In keeping with the rest of the model, it uses a -writec- command to present the multiple-choice response alternatives. Units in the driver scramble the presentation of alternatives prepared by the author so that the correct answer, inserted as the first alternative by the author, may appear on the screen in any one of five alternative positions. The driver units identify the correct answer, so that appropriate feedback can be given to the student when he responds. In the standard format, feedback consists of either, "No. Try again.," or "Very good!"

Authors who wish to use other than the five-part, multiple-choice format substitute their own special units for the standard units. Figure 7 shows a constructed response practice problem used in the multimeter lesson, with appropriate feedback for the response indicated.

Overwrites

Screen locations have been dedicated to alleviate the problem of overwrites. As for other portions of the model, authors who are willing to make their own provisions to prevent overwrites can modify the space provisions to fit their materials. Such modifications need not affect the driver functions.

DISCUSSION

The constructs used to develop the model are derived from the premises stated by Merrill (1973). The model is designed for developing lessons in which learner control of lesson strategy is accepted as an advantageous mode of instruction for both the learner and the author of the instructional lesson. Individuals desiring to develop learner control lessons on the PLATO IV system may copy the model into their own lesson spaces and then insert their own lesson materials.

The paradigm used to develop this particular model has much in common with that being used to develop lessons for the TICCIT system. Since the model is not hardware limited, it could have been developed for the IBM 1500 system as easily as for the PLATO IV system. Further, it doesn't depend heavily on system configuration or software. Thus, the basic lesson structure could easily be applied on any number of hardware systems.

Lesson "learner", the learner control model, makes no special demands on the capabilities of the PLATO IV system. It uses the hardware and software capabilities available. The courseware which makes up a learner control lesson requires no special expertise. However, PLATO users familiar with the problems of adequate extended core storage may encounter one problem: The driver (three blocks) must be attached to all parts of the lesson, so that lessons requiring several lesson spaces may require extra extended core storage. There are no data with which to evaluate the net effect. It may be less or greater than lessons not using learner control, but the problem is worth mentioning. On systems where the driver could be developed as a subroutine, the problem would not exist.

The development of rules, examples, and practice problems for learner control lessons will be a function of the type of material being presented. Some lesson materials will require little more than text, and hence, a minimal departure from the basic lesson format. Others will require more. The flexibility to accommodate diverse materials is very much a part of the "learner" concept. Nothing in the driver or content sections of the model precludes the development of extremely sophisticated displays, constructed response problems, or other complex instructional modes. What an author does is entirely up to him. Some indication of the flexibility of the model is set forth in the lesson itself in the form of "stand-in" content. Additional data may be obtained by examining one of the multimeter or recipe conversion lessons developed for the PLATO IV system. Both the multimeter and recipe conversion lessons depended on graphics for content presentation, particularly the former. Developing these materials was a good step beyond simply replacing text.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of NAVPERSRANDCEN experience with the multimeter and recipe conversion lessons, this model is recommended as a way to create CBI lessons. It should not only reduce CBI development time and provide meaningful instruction to students, but also play some part in bringing the economics of CBI lesson development within reasonable bounds. The two advantages of the model are that it (1) provides a vehicle for learner control of lesson strategies and (2) frees the authors of the necessity for strategy development and testing. There are no decision points to be considered, no mastery criteria to be developed. These become the responsibility of the student, and interestingly enough, he usually makes rational if not optimal decisions.

Although the concepts of developing CBI lessons in which the strategy and content sections are completely independent and providing learner control both have been successfully demonstrated, a need for additional research is indicated. NAVPERSRANDCEN currently is using the multimeter lessons as a vehicle for evaluating the effectiveness of learner control. The learner control mode will be compared to programmed control by substituting a normative programmed driver for the learner control driver in one set of multimeter lesson materials. At the same time, another comparison will test the effect of telling the student what he should do via an "advisor" which uses the same normative driver used for programmed control as a cueing device. The "advisor" will not affect the student's freedom to do what he wants.

REFERENCES

Bitzer, D. L., & Johnson, R. L. PLATO: A computer-based system used in the engineering of education. Proceedings of the Institute of Electrical and Electronics Engineers, 5, 960, 1971.

Evans, J. H., Glaser, R., & Homme, L. E. The RULEG system for the construction of programmed verbal learning sequences. Pittsburgh: University of Pittsburgh, 1960.

Fredericks, P. S., & Hoover-Rice, L. B. An evaluation of learner control CAI and traditional instruction-classroom techniques for recipe conversion. San Diego: Navy Personnel Research and Development Center. (In preparation.)

Gagne', R. M. The conditions of learning. New York: Holt, Rinehart and Winston, Inc. 1970 (2nd edition).

Hurlock, R. E. Applications of pretest branching designs to CAI basic electronics training. San Diego: Naval Personnel and Training Research Laboratory, September 1972. (Research Report SRR 73-8)

Judd, W. A., O'Neil, H. H., Jr., & Spelt, P. F. Individual differences and learner control: Program development and investigation of control over mnemonics in computer-assisted instruction. Air Force Human Resources Laboratory, July 1974. (Technical Report AFHRL-TR-74-30)

Lahey, G. F., Crawford, A. M., & Hurlock, R. E. Use of an interactive general-purpose computer terminal to simulate training equipment operation. San Diego: Navy Personnel Research and Development Center, November 1975. (Technical Report TR 76-19)

Mager, R. F. On the sequencing of instructional content. Psychological Reports, 9, 1961.

Mager, R. F., & Clark, C. Exploration in student controlled instruction. Psychological Reports, 13, 1963.

Mager, R. F., & McCann, I. Learner controlled instruction. Palo Alto, CA: Varian Associates, 1961.

McCann, P. H., Lahey, G. F., & Hurlock, R. E. A comparison of student option versus program controlled CAI training. San Diego: Naval Personnel and Training Research Laboratory, April 1973. (Research Report SRR 73-17)

Merrill, M. D. Premises, propositions, and research underlying the design of a learner controlled computer-assisted instruction system: A summary for the TICCIT system. Provo, Utah: Brigham Young University, Division of Evan Institutional Services, June 1973, (Working Paper No. 44).

Merrill, M. D., & Boutwell, R. C. Instructional development: Methodology and research. In Berlinger, F. N. (Ed.) Review of research in education. Itasca, Illinois: F. E. Peacock, 1973.

Slough, D. A., Ellis, B. D., & Lahey, G. F. Fixed sequence and multiple branching strategies in computer assisted instruction. San Diego: Naval Personnel and Training Research Laboratory, September 1972. (Research Report SRR 73-6)

Stolurow, L. M. Systems approach to instruction. Urbana, Illinois: University of Illinois, Training Research Laboratory, July 1965. (Technical Report No. 7)