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ABSTRACT

Experienced teachers may learn from this manual how to author individualized learning packages. Based on the sequential steps for producing learning materials, a variety of activities for diagnostic, instructional, and evaluative purposes are included in it. The manual is organized into four major parts: (1) "A Model for Individualizing Instruction," which presents a description of individualized instruction and an overview of instructional technology and the training course; (2) "Designing an Individualized Learning Module," which describes each successive step involved in planning and structuring the basic framework for a module and which provides the learning activities necessary for the accomplishment of each step; (3) "Developing an Individualized Learning Module," which includes a description of the techniques required to write and revise a self-instructional package and provides learning activities for the acquisition of any necessary skills; and (4) "Analysis and Assessment of Effectiveness," which provides a description of the procedures for insuring the module effectively teaches what it is designed to teach and for comparing the module with other instructional techniques and/or media. A selected bibliography is appended. (Author/MF)

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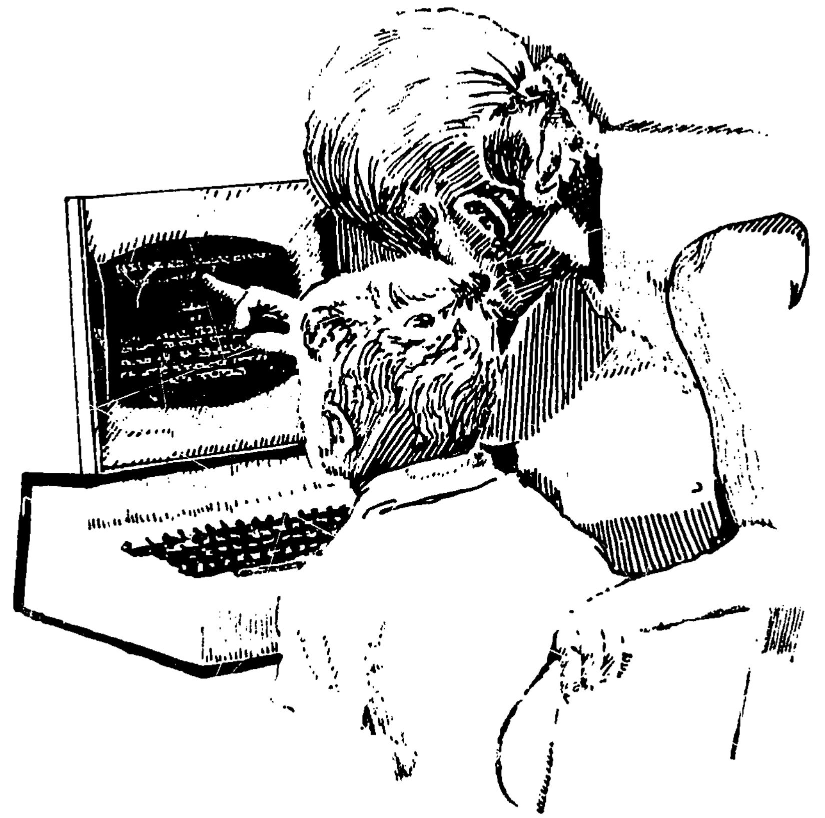
PROJECT REFLECT
COMPUTER-ASSISTED INSTRUCTION PROJECT
TITLE III, E.S.E.A OF 1965



AUTHORING INDIVIDUALIZED LEARNING MODULES:
A Teacher Training Manual

EM 008 760

MONTGOMERY COUNTY PUBLIC SCHOOLS
Rockville, Maryland
Homer O. Elseroad, Superintendent

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PROJECT REFLECT

COMPUTER-ASSISTED INSTRUCTION PROJECT

K-12

Title III, E.S.E.A.

William M. Richardson, Director

AUTHORING INDIVIDUALIZED LEARNING MODULES:

A Teacher Training Manual

by

Kenneth A. Walter

Teacher Specialist in Staff Development

EM 008 760

Project REFLECT
Albert Einstein High School
11135 Newport Mill Road
Kensington, Maryland 20795

Montgomery County Public Schools
Rockville, Maryland
Homer O. Elseroad, Superintendent

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FOREWORD

The decade of the 1960's has been referred to as the period when educators have sought to provide equal educational opportunities for all. The 1970's may be characterized as the period in which we attempted to provide instruction for individuals. Teachers and administrators have long recognized the value and desirability of individualization of the instructional process. The new awareness of behavioral and educational technologies is now providing the mechanism to move in these directions.

The importance of teacher preparation and re-education to the systematic process of change is obvious. Lacking the specific skills to produce and use diagnostic instruments and self-instructional materials required of an individualized instructional system, most educators have been reluctant to venture from the traditional patterns of instruction. The purpose of this documented course of instruction is to assist public schools in filling the gap in teacher preparation and to provide experienced classroom teachers with the skills and knowledges necessary to produce and use self-instructional packages herein referred to as Individualized Learning Modules.

Unlike many teacher education courses, this training program requires that the participants learn through actual practice. The immediate application of each new technique to the trainee's own lesson segment is recommended. This allows each teacher the satisfaction of designing and producing an instructional sequence he may use in his own classroom. At the same time, it provides the instructor with the opportunity to evaluate the participant's progress through observation of his actual performance.

This manual reflects the knowledge and experience gained through the development, operation, and evaluation of an orientation and training program for authors of computer-assisted instruction materials within the Montgomery County Public Schools CAI Demonstration Project. As of this printing, however, many of the materials included have not been validated.

William M. Richardson, Director
CAI Demonstration Project

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INTRODUCTION

PROJECT REFLECT

The Montgomery County Computer-Assisted Instruction Demonstration Project is designed to assess the role of CAI in an operational school setting and to demonstrate the feasibility of staff involvement at all levels in the use of CAI as an instructional medium. This three-year pilot program is funded under Title III of the Elementary and Secondary Education Act of 1965 and represents an effort to develop a system-wide understanding of, familiarity with, and capability for using CAI to improve the educational process in a large school system. The project was funded and initiated in June, 1968, and consists of three one-year phases. The official title of the project is "A Project to Develop Effective Use of Computer-Assisted Instruction in a Large Public School System." The project staff, however, has adopted the name Project "REFLECT," which is an acronym for REsearch into the Feasibility of Learnings Employing Computer Technology.

The project schools, Albert Einstein High School, Newport Junior High School, and Pleasant View Elementary School, are located on adjoining properties in the Kensington-Wheaton area. The high school houses the staff offices and the computer system. Student stations located within the high school and the elementary school are connected by cable to the computer. Terminals were originally planned for Newport Junior High School. However, the level of funding has limited the junior high's participation in the project.

Members of six curriculum design teams who develop and adapt materials for computer use form the nucleus of the project. Each design team is composed of three to four supporting teachers available to the project 10 per cent of their time and a full-time teacher-specialist who, in addition to performing other special functions within the project, provides leadership to the design team. The teams are producing CAI materials, with elementary arithmetic, junior high science, and senior high science (physics and chemistry) and mathematics being given primary emphasis. A few programs are being prepared for elementary language arts and for junior high social studies and French.

A major activity of the project has been to provide the design team members and other interested teachers with the skills and knowledges necessary for producing effective CAI materials.

Three successive groups of teachers, as well as participants in a summer workshop, were exposed to a training program utilizing a variety of materials and instructional techniques. Based on the suggestions of these teachers, on their results on pretest and posttests, on their performance as program authors, and on the observations of project staff members, the course was revised before it was offered to the next group. This accumulated data has been used to develop the training program outlined in this manual.

ORGANIZATION AND USE OF MANUAL

This instructor's manual outlines a course for training experienced teachers to author Individualized Learning Modules. It contains a variety of materials which may be used for various diagnostic, instructional, and evaluative activities. Since it is assumed that the instructor is a trained and experienced instructional technologist, only a few general suggestions on the use of this manual are indicated in this introductory section. Additional sections containing suggested procedures, materials, and sources are distributed through the manual to aid the instructor. The arrangement of materials within the manual is designed to allow the instructor the option of either duplicating any appropriate materials or using them as a model for developing his own.

Based on the sequential steps required for the production of an Individualized Learning Module, the main body of this manual is organized into four major parts:

I. A Model for Individualizing Instruction--presents a description of individualized instruction and an overview of instructional technology and the training course.

II. Designing an Individualized Learning Module--describes each successive step involved in planning and structuring the basic framework for a module and provides the learning activities necessary for the accomplishment of each step.

III. Developing an Individualized Learning Module--includes a description of the techniques required to write and revise a self-instructional package and provides learning activities for the acquisition of any necessary skills.

IV. Analysis and Assessment of Effectiveness--provides a description of the procedures for insuring that the module effectively teaches what it is designed to teach and for comparing the module with other instructional techniques and/or media.

Parts II, III, and IV, described above, are divided into topics corresponding with the individual steps necessary for producing an Individualized Learning Module. Many of these steps require the acquisition of specific skills and knowledges and others do not. Those steps which require no special skills or knowledges, or skills experienced teachers would already have acquired, are simply described with the important procedures outlined. However, since most of the steps concerning the design and development of a module (topics II and III) do require the author to use special techniques, these steps are further subdivided into sections. Some of the following sections are included in every topic:

1. A brief description of the topic
2. The list of objectives
3. A diagram of the learning sequence (included only when the objectives may be organized other than in a linear sequence)
4. An outline of suggested procedures

5. Examples for illustrative or instructional purposes

6. Criterion items (labeled "Activities") for each objective

The supplementary materials and information within the appendices constitute the final portion of this document. Appendices A through D contain the objectives, descriptive materials, learning activities, and procedures employed in Project REFLECT's CAI Author Training Program. These sections supply the learning activities and specific procedures used to develop materials for the IBM 1500 Instructional System. Appendix E supplies the answer key for the criterion items and activities included in the various topics. Sources mentioned throughout the manual are listed in Appendix F. This bibliography includes only those items most useful and relevant for training teachers as authors of individualized materials.

To a large extent, the effectiveness of the outlined training program will depend not only on the instructor's knowledge and skill as an instructional technologist but on his ability and willingness to create the same type of learning environment and to employ the same instructional and evaluative techniques which he would like teachers to create and employ in their own classrooms. In other words, the participants may learn as much from the manner in which the course is conducted as they will from the content.

In addition to the instructor's qualifications and ability, the success of this program is based on three more assumptions. First, the participants are successful, experienced teachers who combine some degree of creativity with a desire to learn new techniques. Second, since a great deal of individual instruction and evaluation is required, the training group is limited in size--dependent on the number of instructors and the amount of self-instructional materials available. Finally, the importance of the training has been established by providing time during the regular working day and by granting university or workshop credit for participating in the course.

During the first training session of the course, it is recommended that a pretest be administered to establish the entering behaviors of the participants. This information, when compared with the results of a posttest, provides the data required to evaluate the effectiveness of the training program. These tests may be constructed by employing the criterion items provided for the terminal objective(s) in each topic.

The following general procedures are suggested for each topic:

1. Assemble instructional materials (including the duplication of any material from this manual)

2. Introduce section

   a) Describe skill(s) or task(s) to be learned

   b) Relate section to the instructional technology diagram.

   c) Provide section description, objectives, and example(s)

3. Arrange for instruction.

    a) Conduct or provide for learning activities

    b) Supply specific examples for several subject areas

    c) Encourage trainees to assume responsibility for accomplishing each objective but to seek help when necessary

4. Test trainees on the terminal behavior and require them to apply the newly acquired knowledge and skill to the appropriate developmental phase of their lesson segment.

5. Arrange for evaluation of the lesson segment by a trained technologist having experience with the target population and in the subject area, if possible.

PART I

A MODEL FOR INDIVIDUALIZING INSTRUCTION

Research and experience during the past 50 years or so have indicated each person learns in his own unique way and at his own rate. While private industry and the military have developed successful educational and training programs based on a student-centered approach, the public schools have, with few exceptions, done very little in this direction. Although many educators say individualized instruction is important and should be implemented, few agree on what individualized instruction means, on how it should be accomplished, or on its implications for the entire educational system.

A. INDIVIDUALIZED INSTRUCTION

Before the problem of how to individualize instruction can be addressed, a clear and generally accepted description of the objective must be made. Individualized instruction is not the same as independent study. There are times a student in an individualized program may be engaged in self-instructional activities; however, there also will be occasions when he will learn as a member of a group or receive tutoring by the teacher, an aide, or another student.

In an individualized instructional setting, each student progresses at his own rate through a learning experience which is tailored to his own needs, interests, and learning style, thereby optimizing the likelihood of his attainment of specific objectives. This description implies that certain important conditions are essential:

1. The level of achievement and skill development in particular learning sequences is identified for each student through a variety of diagnostic activities.

2. Planning together, each student and his teacher select and develop a set of specific performance objectives toward which the student should work. These objectives take into consideration the diagnostic activities cited in statement number one and the needs and interest of the student.

3. For each objective, a variety of materials and procedures must be available to each student so that those most appropriate to him may be selected.

4. Each student works toward the attainment of objectives at his own rate.

5. Each student's progress is measured by comparing his performance with his specific objectives rather than with the performance of other students.

In the above setting, the teacher is the manager of the learning environment. Activities of the teacher include diagnosing students' learning difficulities, prescribing instructional activities, and tutoring individuals and small groups. Rarely does he work with the entire class.

B. INSTRUCTIONAL TECHNOLOGY: AN OVERVIEW

Technology refers to the application of scientific knowledge, methods, and research to solve a particular practical problem. This may or may not involve the use of machines.

Instructional technology is a process based on the principles used in systems engineering. An instructional system includes all equipment, procedures, materials, facilities, personnel, etc. required to produce learning. The systems approach involves the arrangement of these various elements so as to maximize the learning of the individual student. The diagram on page 8 illustrates the set of procedures used by instructional technologists to develop effective individualized learning materials regardless of the media employed. Each of the numbered steps in the diagram is described in the following:

1. Select a topic for development based on the requirements of the target population and on curriculum needs.

2. State specifically what the student will do at the end of the learning experience (the terminal objective(s)).

3. Construct a learning hierarchy which includes the following steps:

    a) Analyze the task(s) described in the terminal objective(s) into component tasks.

    b) Write the subordinate (enabling) objectives necessary for attainment of the terminal behavior(s).

    c) Order the enabling objectives into a learning dependency relationship.

    d) Identify the entering behaviors.

4. Develop criterion items to measure whether or not an individual has acquired the specific behavior(s) described in each objective.

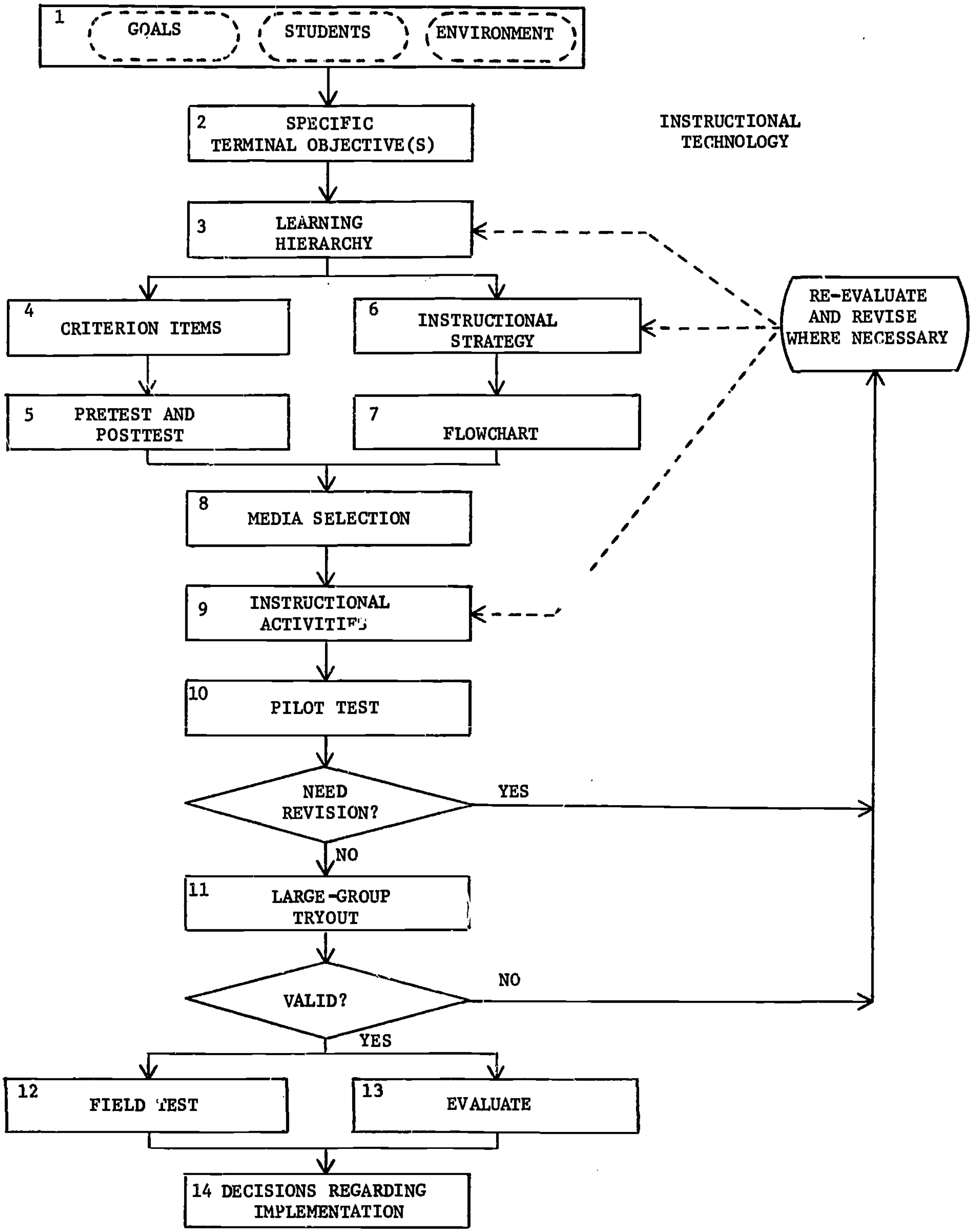
5. Using the criterion items, assemble an entering behaviors test, a pretest, a posttest, and a diagnostic test, if desirable.

6. Devise a plan (instructional strategy) describing every possible path a student could follow through a lesson segment and indicating the conditions which determine each path.

7. Draw a diagram (flowchart) illustrating the instructional strategy.

8. Select the medium or media (worksheet, programmed text, slides, audio tape, 8mm film, video tape, CAI, etc.) for communicating the instructional message to the learner.

9. Develop the learning activities designed to provide the student with the skills and knowledges necessary to attain each objective.



INSTRUCTIONAL TECHNOLOGY

1
GOALS
STUDENTS
ENVIRONMENT
2 SPECIFIC TERMINAL OBJECTIVE(S)
3 LEARNING HIERARCHY
4 CRITERION ITEMS
6 INSTRUCTIONAL STRATEGY
RE-EVALUATE AND REVISE WHERE NECESSARY
5 PRETEST AND POSTTEST
7 FLOWCHART
8 MEDIA SELECTION
9 INSTRUCTIONAL ACTIVITIES
10 PILOT TEST
NEED REVISION?
YES
NO
11 LARGE-GROUP TRYOUT
VALID?
NO
YES
12 FIELD TEST
13 EVALUATE
14 DECISIONS REGARDING IMPLEMENTATION

10. Use the lesson segment (pilot test) with small number (5-10) of students fro
the target population. Revise if and where necessary.

11. Use the instructional sequence with large group (30-50) of students from the target population to determine if it teaches what is purports to teach (Is it valid?). Revise if and where necessary.

12. Field test the module with several student populations similar to the large group used in the validation process.

13. Employ the module with experimental and control groups in order to gather data for comparing the effectiveness of one method of instruction and/or type of media with another.

14. Based on the data collected in steps 12 and 13, make decisions concerning the implementation of the package.

OBJECTIVES

At the end of this learning experience the participant will:

1. Define individualized instruction.
2. Given a diagram illustrating instructional technology, describe each step of the process.

A MODEL FOR INDIVIDUALIZING INSTRUCTION - Suggested Procedures

I. Introduction

- A. Explain the purpose of the course.
- B. Describe the method of instruction.
- C. Administer a pretest, if desired.

II. Overview of Course

- A. Provide participants with copies of the topic description and objectives.
- B. Discuss individualized instruction.
- C. Use the diagram on instructional technology as a basis for presenting an overview of the course.

III. Bibliography

- A. Banathy, Bela H. Instructional Systems. Palo Alto, Calif.: Fearon Publishers, 1968.
- B. Esbensen, Thorwald. Working with Individualized Instruction: The Duluth Experience. Palo Alto, Calif.: Fearon Publishers, 1968.

PART II

DESIGNING AN INDIVIDUALIZED LEARNING MODULE

Authoring an individualized learning module requires a combination of technique and creativity. Many beginners plunge directly into the creative aspects of writing the instructional sequence and preparing materials and neglect the important techniques involved in designing the module. The production of a learning module is accomplished in three separate and distinct states: (1) design, (2) development, and (3) evaluation.

This topic deals with the design stage which is nearly all technique. The beginning author may be tempted to rush through this stage, but the time spent in designing the module at this point will save time and frustration in the long run. Experienced authors estimate that from 25 to 40 per cent of the total time required to produce a validated learning module is spent on design. The completion of this stage involves the accomplishment and documentation of the following steps:

1. Selecting a topic
2. Defining the terminal objective(s)
3. Constructing a learning hierarchy
    a) Analyzing the task(s)
    b) Writing enabling objectives
    c) Ordering objectives into a learning dependency relationship
    d) Identifying the entering behaviors
4. Developing criterion test items
5. Assembling an entering behaviors test and the pretest/posttest

A. DOCUMENTATION

Accurate record keeping is an important aspect of the development of learning materials. Such documentation is important not only to conserve time and effort on the material currently under development, but also as an aid in the evolving of additional modular units. This recording should be made as events occur. Entry in a notebook as each milestone is passed has been found helpful. In a field where a time frame is essential to evaluation, documentation of time expenditure is also necessary. A backup copy of materials often has great value.

Following selection of a topic, the factors affecting the choice should be recorded. As each step in the designing of the learning module is achieved, the appropriate documentation should occur. Supportive evidence of the terminal objectives; the resultant task analysis; the hierarchy construction; the enabling objectives; the entering behaviors; criterion items for the terminal objectives; enabling objectives and entering behaviors; and the pretest, posttest, and test of entering behaviors are a part of the design of the Individualized Learning Module.

B. SELECTING A TOPIC

An experienced teacher may be capable of producing highly effective instructional materials. However, this is no assurance that the material teaches anything worth knowing. In fact, it is possible to use the new technology to teach better those things which should not be taught at all. Therefore, the first and one of the most important steps in the development of an individualized learning module is the careful selection of a topic.

In addition to the general factors which influence curriculum decisions within a school system, certain specific questions should be considered when selecting a topic for development. (1) Is there a need for the lesson segment, as evidenced by the opinions of students, the observations of teachers, and the lack of adequate individualized instructional materials on the topic? (2) Does the instructional sequence cover a single concept which may be inserted into the existing curriculum? (3) Has the author taught this concept to a student population similar to the one for which he is developing the lesson segment? (4) If this is the author's first instructional module, is the concept one which may be easily analyzed into its component tasks?

Note: Participants should begin to think about possible topics at this time but may wait until the completion of the section on instructional objectives before making a final decision.

C. TASK ANALYSIS

The task analysis is an important step in the development of a lesson segment. It serves as a logical starting point because this is a necessary skill for selecting a topic which may be easily analyzed and the acquisition of this skill depends more on common sense than on learning a specific body of knowledge or new technical terms.

Every day the average person performs many tasks without thinking about each of the individual steps necessary for their accomplishment. For example, to make a telephone call to the desired party, one must follow a set of procedures in a prescribed order: (1) look up or recall the number, (2) pick up the receiver, (3) wait for the dial tone, (4) dial the number, (5) wait for the person to answer, and (6) carry on the conversation.

Analyzing a task involves separating a task into its component elements as was done with the telephone call. This task analysis is accomplished by thinking through or actually performing each step necessary to complete a particular task and then recording it in the sequence in which it must be performed. It should be noted that in many tasks some steps may occur in any order, and others are dependent on the one before it. For complex tasks, it is necessary to construct a diagram to show the relationship of one step to the other.

OBJECTIVES

At the end of this learning experience the participant will demonstrate an ability to analyze a task. He will:

1. Given a simple task, analyze it into its component parts, and organize them in a logical sequence.

2. Select a task a student might be expected to learn. Do a task analysis, and organize the component tasks into a logical sequence.

TASK ANALYSIS - Suggested Procedures

I. Introduction

A. Provide the group with copies of the topic description and objectives.

B. Emphasize that there is no one correct analysis for many tasks.

NOTE:

1. Since this skill is the basis for selecting a topic, for constructing hierarchies, and for flowcharting, it is recommended that sufficient time be allowed for this topic. In the long run it will save time and prevent frustration later in the course.

2. The examples provided represent only one way the given tasks might be analyzed. They could include different elements and could be organized somewhat differently.

II. Instruction

A. Analyze a simple task with the class.

B. Give the entire class a simple task.

1. Have the participants analyze the task individually.

2. Develop a diagram of the analysis with the entire group.

III. Practice

A. Have the participants select several everyday tasks from a given list and analyze them.

B. Check each analyzed task and have the individual make any necessary corrections before going to the next task.

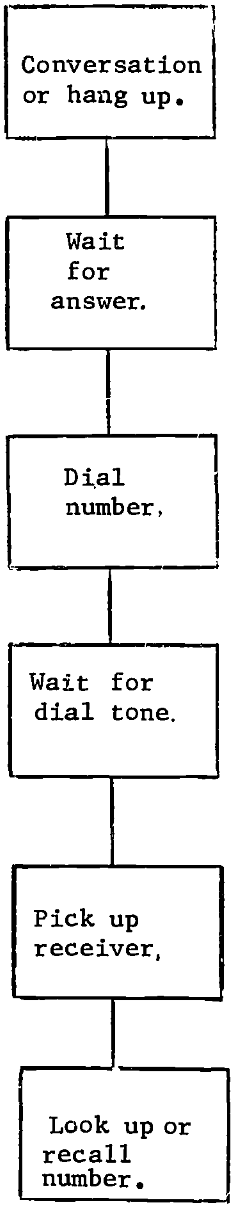
C. When each participant is able to correctly analyze several everyday tasks, he should select a simple skill he might expect a student in his class to perform, analyze it, and organize the components into a logical sequence.

D. Each of the analyzed tasks should be checked by a technologist with a knowledge of the task.

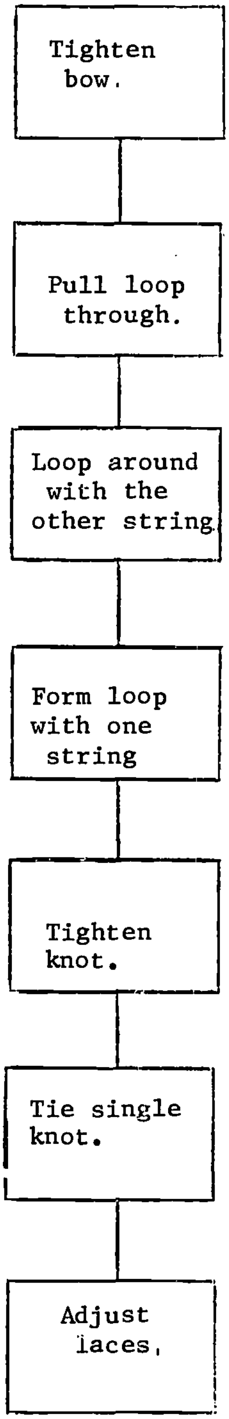
IV. Application--The participants will apply this skill to their topics after they learn to write instructional objectives.

TASK ANALYSIS - Examples A and B

Making a telephone call

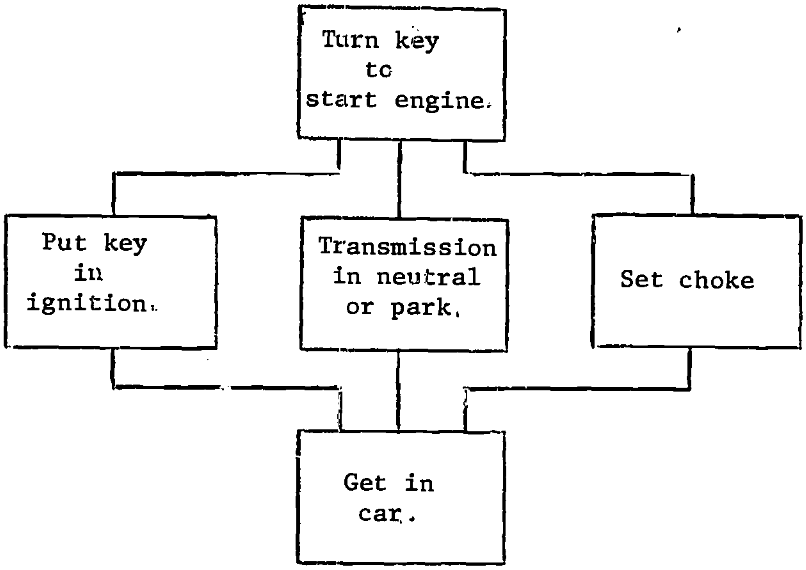

Conversation or hang up.
Wait for answer.
Dial number,
Wait for dial tone.
Pick up receiver,
Look up or recall number.

Tying a shoe

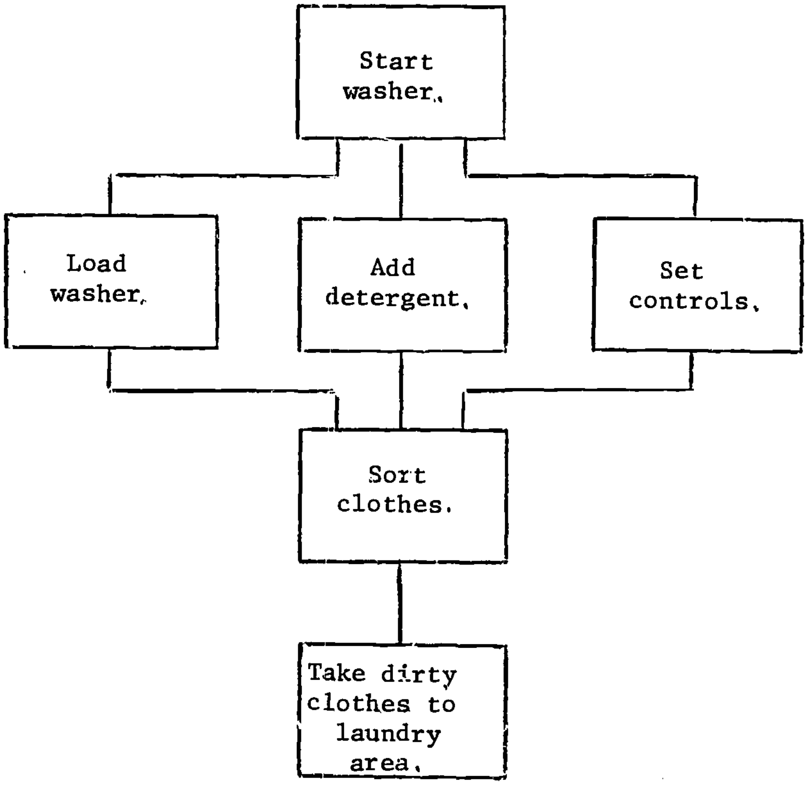

Tighten bow.
Pull loop through.
Loop around with the other string.
Form loop with one string
Tighten knot.
Tie single knot.
Adjust laces,

TASK ANALYSIS - Example C and D

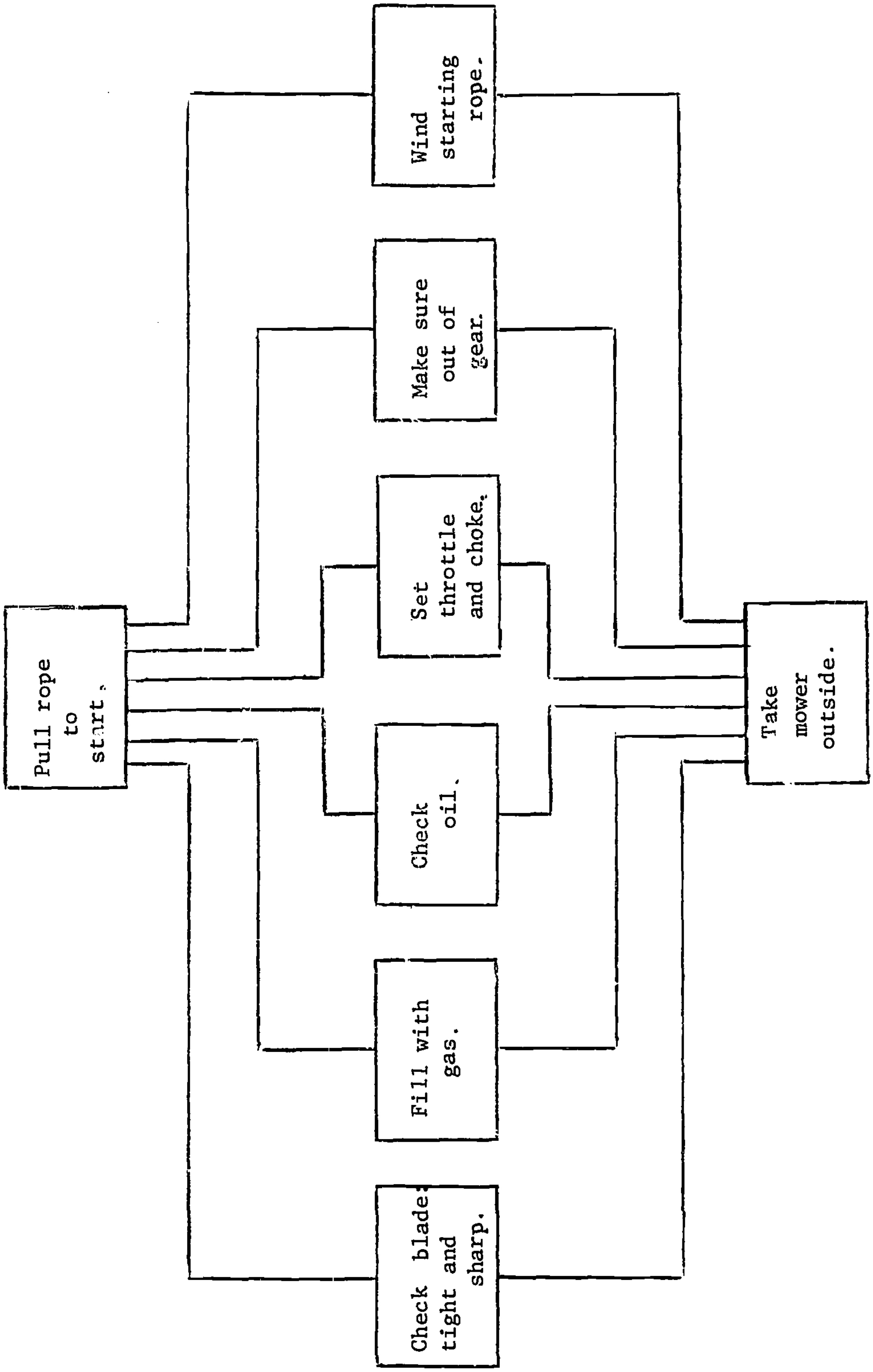
Starting a car on a cold day


Turn key to start engine.
Put key in ignition.
Transmission in neutral or park.
Set choke
Get in car.

Washing clothes in an automatic machine

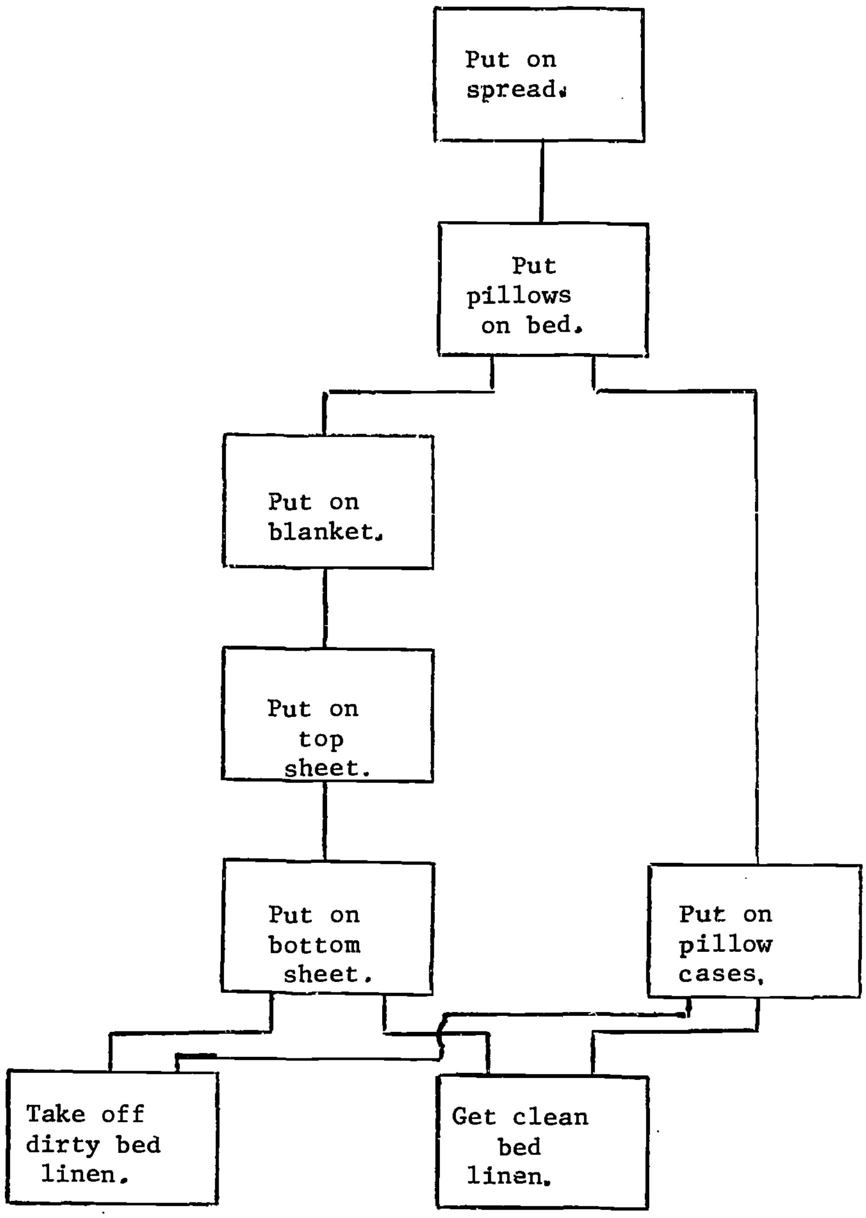

Start washer.
Load washer.
Add detergent.
Set controls.
Sort clothes.
Take dirty clothes to laundry area.

TASK ANALYSIS - Example E


Take mower outside.
Wind starting rope.
Make sure out of gear.
Set throttle and choke.
Check oil.
Fill with gas.
Check blades tight and sharp.
Pull rope to start.

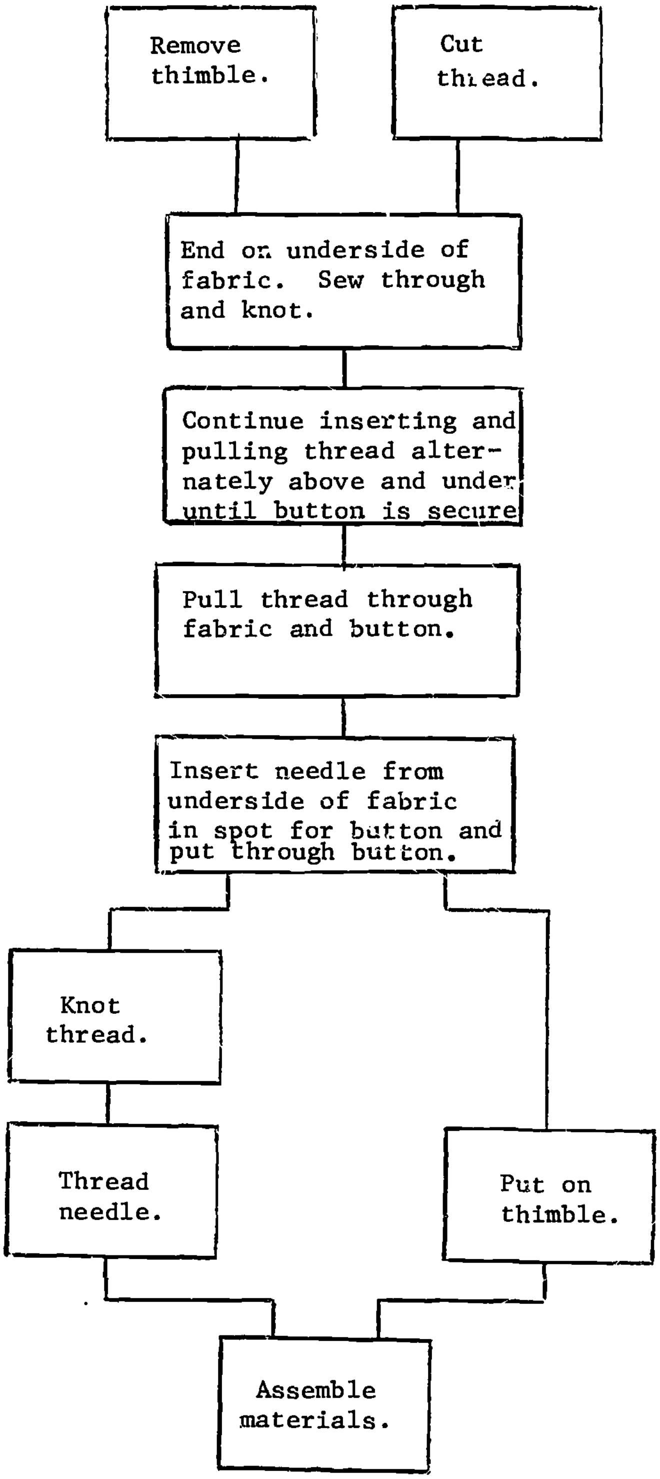
Starting a self-propelled rotary mower

TASK ANALYSIS - Example F


Changing a Bed
Put on spread.
Put pillows on bed.
Put on blanket.
Put on top sheet.
Put on bottom sheet.
Put on pillow cases.
Take off dirty bed linen.
Get clean bed linen.

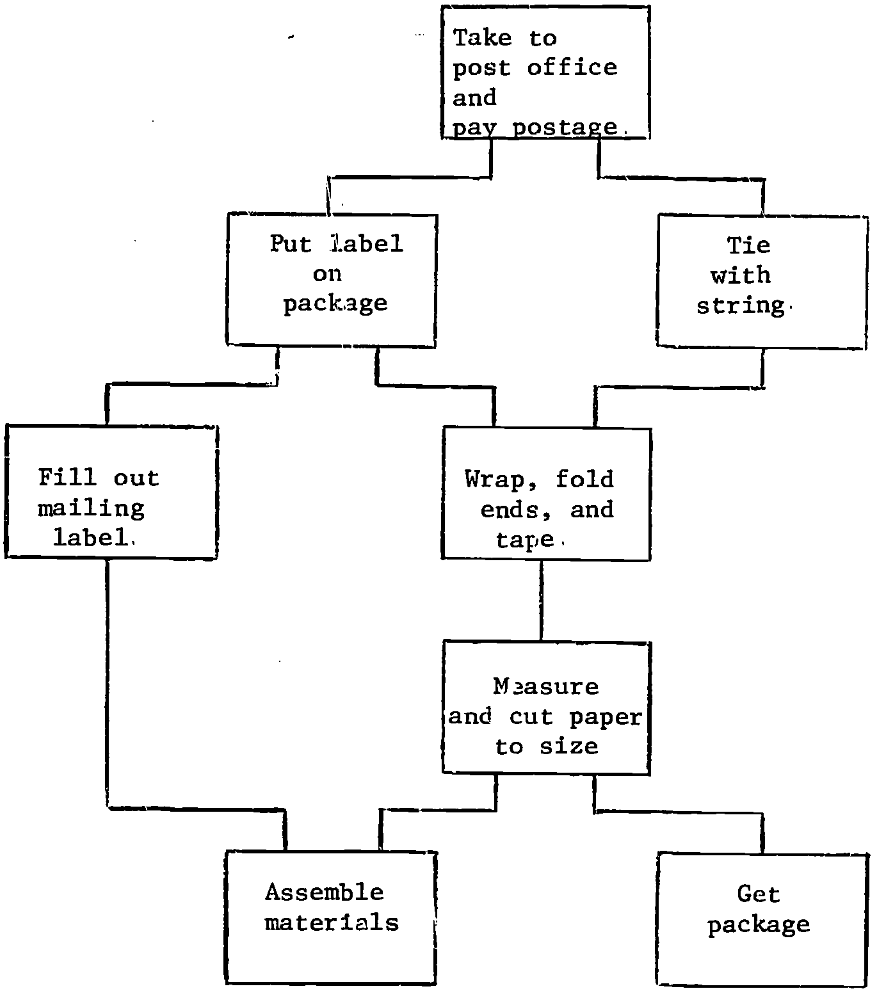
TASK ANALYSIS - Example G

Sewing on a Button


Remove thimble.
Cut thread.
End on underside of fabric. Sew through and knot.
Continue inserting and pulling thread alternately above and under until button is secure
Pull thread through fabric and button.
Insert needle from underside of fabric in spot for button and put through button.
Knot thread.
Thread needle.
Put on thimble.
Assemble materials.

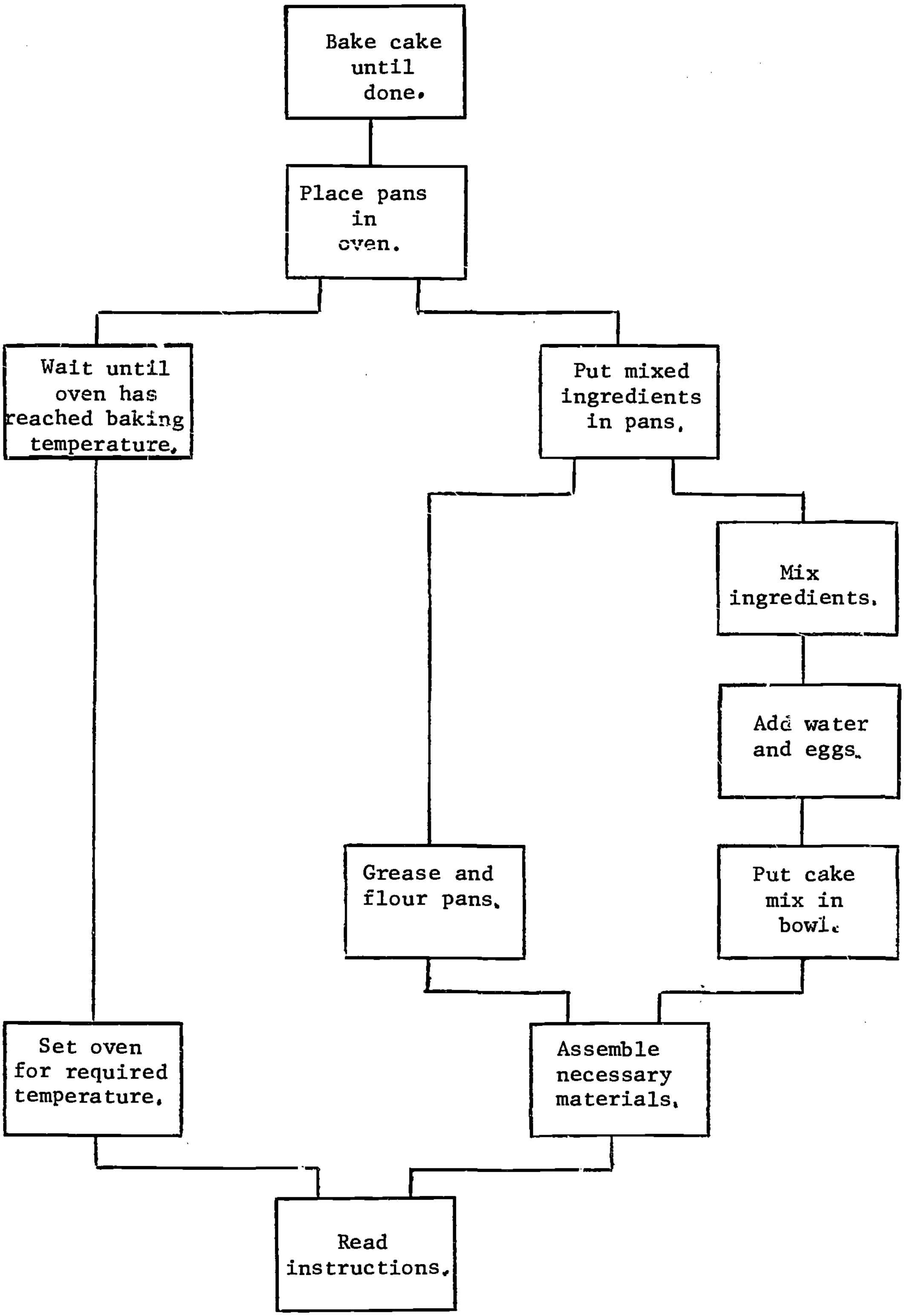
TASK ANALYSIS - Example H

Wrapping and Mailing a Package


Take to post office and pay postage.
Put label on package
Tie with string.
Fill out mailing label.
Wrap, fold ends, and tape.
Measure and cut paper to size
Assemble materials
Get package

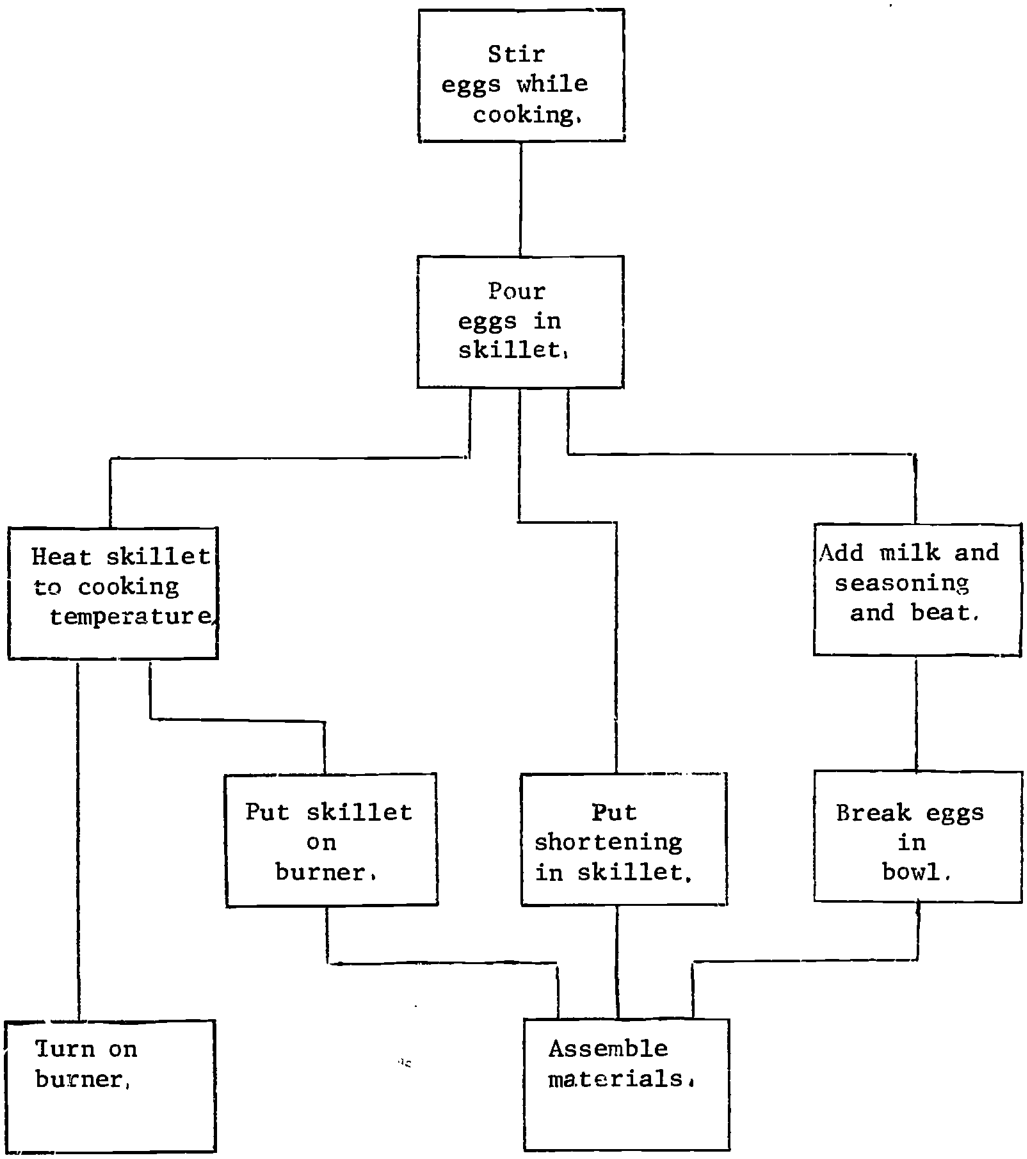
TASK ANALYSIS - Example I

Baking a Cake Using a Mix

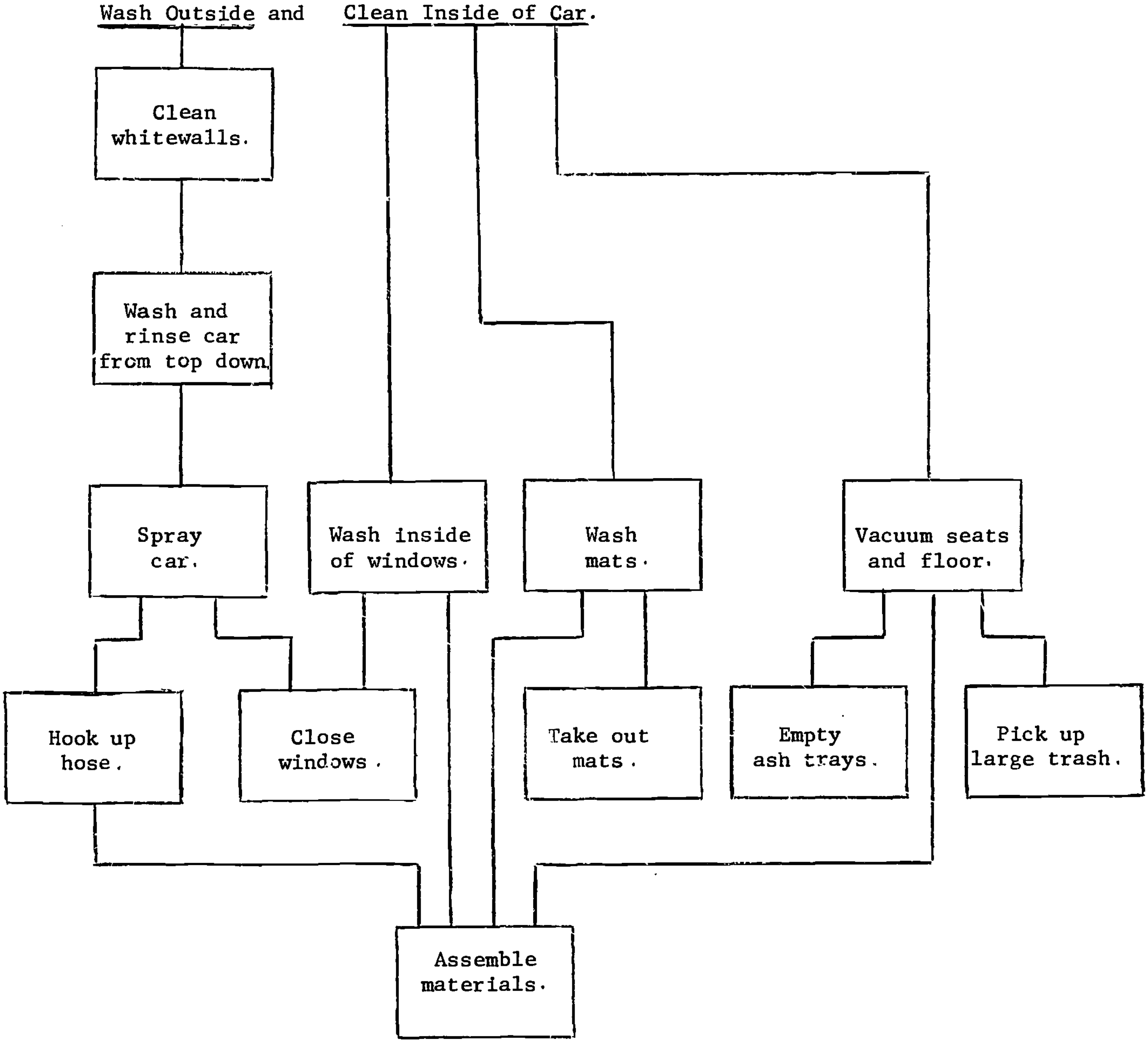

Bake cake until done.
Place pans in oven.
Wait until oven has reached baking temperature.
Put mixed ingredients in pans.
Mix ingredients.
Add water and eggs.
Grease and flour pans.
Put cake mix in bowl.
Set oven for required temperature.
Assemble necessary materials.
Read instructions.

TASK ANALYSIS - Example J

Frying Scrambled Eggs


Stir eggs while cooking.
Pour eggs in skillet.
Heat skillet to cooking temperature.
Add milk and seasoning and beat.
Put skillet on burner.
Put shortening in skillet.
Break eggs in bowl.
Turn on burner.
Assemble materials.

TASK ANALYSIS - Example K


Wash Outside and Clean Inside of Car.
Clean whitewalls.
Wash and rinse car from top down.
Spray car.
Wash inside of windows.
Wash mats.
Vacuum seats and floor.
Hook up hose.
Close windows.
Take out mats.
Empty ash trays.
Pick up large trash.
Assemble materials.

D. INSTRUCTIONAL OBJECTIVES AND CRITERION TESTS

Once the topic has been selected, the next, and probably the most important, step in the development of an individualized learning module, is the writing of instructional objectives. Well-written objectives should clearly and precisely describe what the learner will be able to do when he has successfully completed a learning experience. In addition, the conditions under which the learner is to perform and the criteria for his success should be accurately stated. A carefully prepared set of objectives provides the basis for:

1. Developing an effective instructional sequence including the selection of appropriate materials, media, content, and methods.
2. Determining if a student has the prerequisite skills and knowledge to be successful in an instructional sequence.
3. Constructing diagnostic tests used to determine the point(s) at which a student should enter an instructional sequence.
4. Constructing tests which accurately identify learners who have attained the lesson or program objectives.
5. Determining whether or not the learning sequence teaches what it purports to teach (Is it valid?).
6. Evaluating a variety of factors included in and related to an instructional sequence.
7. Allowing students to evaluate their own progress.

Criterion (or assessment) items complement the instructional objectives for a lesson segment by measuring an individual learner's attainment of the specific behavior(s) described in each objective. In addition to being employed individually, criterion items may be assembled for use as a pretest/posttest and diagnostic instruments.

OBJECTIVES

At the end of this learning experince, the participant will:

1. Given a list of instructional objectives, identify those stated in terms of student performance.
2. Given a list of objectives written in nonbehavioral terms, select at least five statements and construct instructional objectives that state the student's behavior in performance terms.
3. Given an instructional objective, identify the portion of it that describes the conditions under which the behavior will be expected to occur.

4. Given an instructional objective in an area of common knowledge with student performance specified, construct the portion that describes the conditions under which the behavior will be expected to occur.

5. Given an instructional objective, identify the portion of it that defines minimum acceptable performance.

6. Given an instructional objective in an area of common knowledge with student performance and the conditions specified, construct the portion that defines minimum acceptable performance.

7. Name the three components of an instructional objective and describe each.

8. Given an objective in an area of common knowledge stated in nonbehavioral terms, construct an instructional objective which includes the three components.

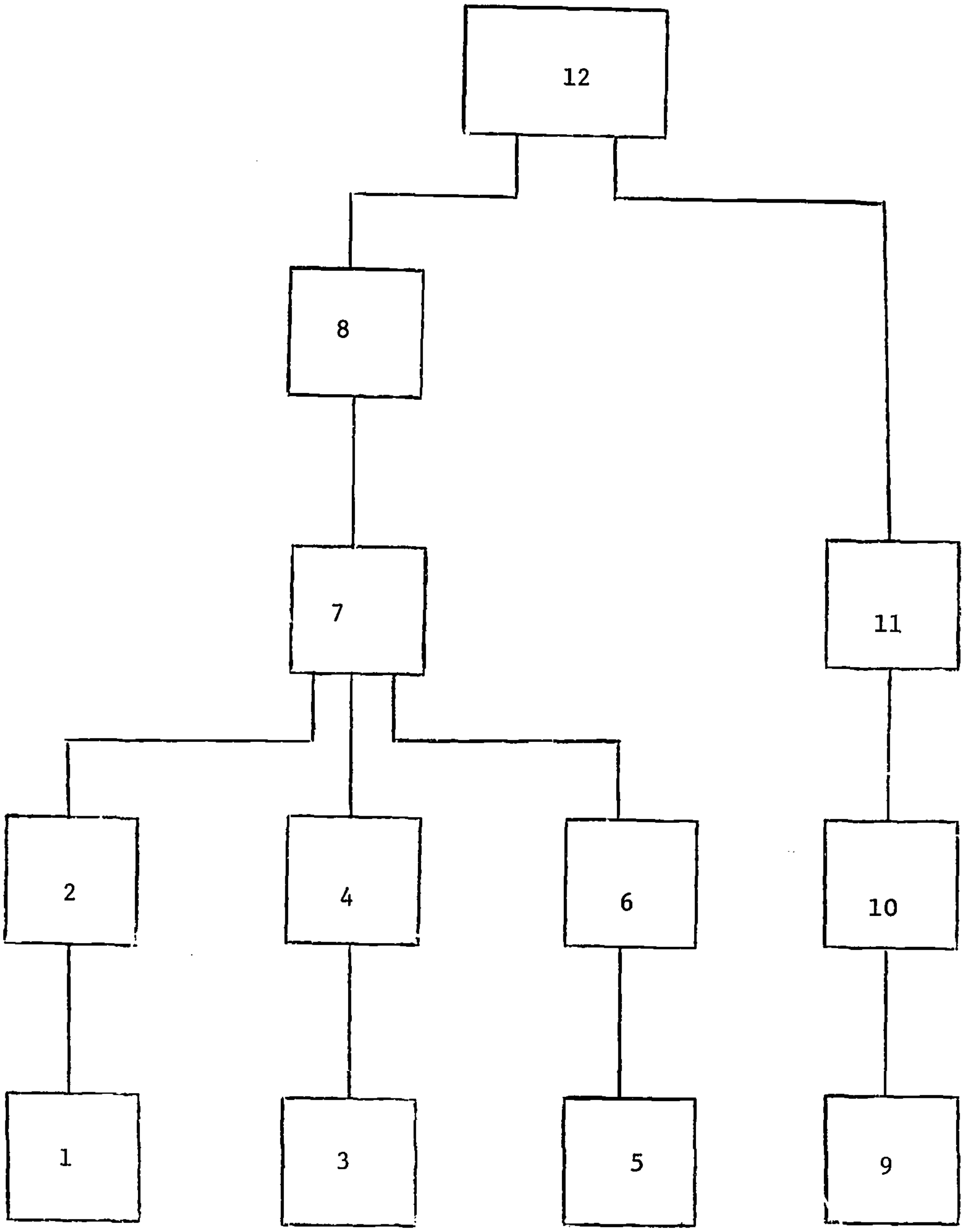
9. Given an instructional objective in an area of common knowledge, the definition of criterion test, and more than one criterion test item, identify the test item(s) which accurately measure the attainment of the objective.

10. Describe the characteristics which made each of the test items not identified in number nine unsuitable as criterion tests for the objective.

11. Given an instructional objective, construct a criterion test item which will assess the attainment of the objective.

12. Construct an objective which clearly and precisely describes what the learner will be able to do when he has successfully completed a learning experience, the conditions under which he is to perform, and the criteria for his success. Construct a criterion item for the objective.

INSTRUCTIONAL OBJECTIVES - Hierarchy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INSTRUCTIONAL OBJECTIVES AND CRITERION TESTS - Suggested Procedures

I. Introduction

A. Provide class with copies of the topic description and objectives.

B. Discuss the importance and use of instructional objectives.

C. Define criterion tests.

II. Instruction

A. Have class read Robert F. Mager's Preparing Instructional Objectives.

B. Have each member of the class do Activities 1-11 (pages 29 to 40).

1. Use Henry H. Walbesser's "Definition of Action Words" with Activity 2.

2. Check each participant's completed activities and have necessary corrections made before proceeding to next activity.

III. Practice

A. Have participants do Activity 12.

B. Have a technologist with a knowledge of the subject area or the skill check this activity.

IV. Application--If Activity 12 was not the terminal objective for the trainee's lesson segment, have student construct it at this point.

V. Bibliography

A. Esbensen, Thorwald. Working with Individualized Instruction: The Duluth Experience. Palo Alto, Calif.: Fearon Publishers, 1968, pp. 3-14.

B. Mager, Robert F. Preparing Instructional Objectives. Palo Alto, Calif.: Fearon Publishers, 1962.

C. Walbesser, Henry H. Constructing Behavioral Objectives. College Park, Maryland: College of Education, University of Maryland, 1968.

INSTRUCTIONAL OBJECTIVES -- Activity 1 (also used for Activity 2)

Circle the numbers of the following objectives which are stated in terms of student performance:

1. At the end of this session, the student will know the eight fundamental processes necessary to sustain life.
2. Given a situation, the student will set up problems involving direct variation.
3. At the end of this program, the student will describe the effect on the bending of the light ray produced when the angle of incidence is changed.
4. The student will solve equations of form $ax^3=b$.
5. The geography student will understand the relationships between man and his environment.
6. The data processing student will state the principle used in the magnetic "core" storage device.
7. At the end of the unit, the U.S. History student will understand the ideas embodied in the Declaration of Independence.
8. At the end of this lesson, the chemistry student will write the formula for a chemical compound when given its name.
9. The ninth grade student will acquire sound and positive attitudes with respect to the use of stimulants and narcotics.
10. The teacher will help the pupil develop the concept of a line and of a line segment.
11. The fifth grader will know how to read the thermometer in measuring temperature.
12. The physics student will identify a straight line graph as a representation of a direct proportion between variables.
13. At the end of this unit, the student will be aware of the biological problems which man may encounter in space travel.
14. Given a replica of the earth with the Prime Meridian indicated, the student will name the eastern and western hemispheres.
15. The purposes of this lesson is to explain the role of a model in scientific investigation and introduce the familiar molecular model of a gas.
16. The civics student will learn the rights and duties of citizenship.

INSTRUCTIONAL OBJECTIVES - Activity 1 (continued)

17. At the end of this lesson, the student will use the principal ray method to construct the path of a light ray entering the lens parallel to the principal axis of the lens.

18. The seventh grader will appreciate mathematics as an invention of the human mind and as a product of historical development.

19. The student will add two, two-place numerals without regrouping.

20. Given a Vernier Caliper, the student distinguishes between the Vernier and the fixed scale.

INSTRUCTIONAL OBJECTIVES - Activity 2

Employing the list used for Activity 1, select at least five of the objectives stated in nonbehavioral terms. In the space below rewrite them so that they are stated in terms of student performance.

INSTRUCTIONAL OBJECTIVES - Activity 3

Underline that portion of the following objective which describes the conditions und
which the student will be expected to perform:

> Within a maximum of six minutes, using a globe with five cities clearly indicated, the student will correctly name, with not more than a 2° error, the latitude and longitude coordinates for each city.

INSTRUCTIONAL OBJECTIVES - Activity 4

The following objective is stated in terms of student performance. Construct that portion of the objective that describes the conditions under which the student is to perform.

The student will write the

letters of the alphabet.

INSTRUCTIONAL OBJECTIVES - Activity 5

Underline that portion of the following objective which defines minimum acceptable performance:

> The student will fill in on a map the names of each state and of the twenty largest cities in the United States, given a map with the states outlined and the cities designated by a star. The names must be correctly spelled and completed in a single attempt.

INSTRUCTIONAL OBJECTIVES - Activity 6

The following objective describes the student's performance and the conditions under which he is expected to perform. Construct that portion of the objective which defines minimum acceptable performance.

Given a paragraph with ten capitalization errors, the student will correct the errors.

INSTRUCTIONAL OBJECTIVES - Activity 7

Name the three components of an instructional objective and describe each.

1. ______________________________

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2. ______________________________

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3. ______________________________

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INSTRUCTIONAL OBJECTIVES - Activity 8

Using the following statement, construct an instructional objective which includes the three components:

> The student will know the motivating factors that lead to the use of alcohol, narcotics, or tobacco.

INSTRUCTIONAL OBJECTIVES - Activity 9

A criterion test provides the evidence necessary to assess the student's acquisition of the behavior described in the instructional objective.

Objective: The student will be able to inscribe a circle in a given triangle using uncalibrated devices.

Which of the test situations below would elicit the kind of behavior which would indicate the student had reached the objective?

a. Student will be given a paper with a triangle drawn on it and, using compass and straightedge, will inscribe a circle within that triangle.

b. Student will list in proper sequence the steps necessary to inscribe a circle in a triangle.

c. Student will go to chalkboard, draw triangle, and inscribe a circle in it using chalkboard compass and straightedge.

INSTRUCTIONAL OBJECTIVES - Activity 10

Two of the three test items supplied in Activity 9 are not valid criterion items for the objective. In the space below, describe the characteristics which make each of those items invalid.

INSTRUCTIONAL OBJECTIVES - Activity 11

Construct a criterion test item which will assess whether the following objective has been attained:

> Given sentences illustrating multiplication such as 2x3=6 the student will identify the number which is the product and the numbers which are factors.

INSTRUCTIONAL OBJECTIVES - Activity 12

Select a task you might expect a student in your class to perform after receiving instruction. In the space below, (1) write an instructional objective describing the task so clearly and precisely that another teacher in your subject area could use the objective to identify students who had successfully attained the objective and (2) construct a criterion test item for the objective.

E. CONSTRUCTING HIERARCHIES

The arrangement of instructional objectives into the learning sequence necessary for the attainment of the terminal objective(s) is often referred to as a learning hierarchy. Objectives ordered in this manner serve as a guide for (1) writing the lesson segment, (2) establishing the prerequisite behaviors required for the successful completion of the instructional sequence, and (3) constructing diagnostic tests.

Constructing a hierarchy begins with a task analysis of the terminal objective(s). Remember the telephone call which was analyzed into a series of component tasks, each one essential for the completion of the main task. By stating each of those component tasks as an instructional objective, the basic framework of a hierarchy for an instructional lesson on "making a telephone call" would be established.

The next step would be to examine each of the objectives and determine if any additiona skills or knowledges are necessary for its accomplishment. In some cases, there would be none. But others, such as "looking up the phone number," require the ability to read at a certain level and a knowledge of alphabetical order. Each of these additiona requirements must also be described in behavioral terms. This process is continued for each component task until the skills and knowledges the learner can be expected to bring to the instructional situation are reached. Using the basic framework establishe by the task analysis, each of the subordinate behaviors is then ordered into its learning dependency relationship to other subordinate behaviors and to the terminal objective(s). A final check should be made to assure that all of the behaviors indicated in the terminal objective(s) have been included in the subordinate objectives

When the hierarchy is completed, it should look something like the following descriptio (see Example B, pages 47 to 49): (1) the top level of the hierarchy consists of the terminal objective(s) for the instructional sequence; (2) those prerequisite behaviors necessary for successful performance within the lesson segment form the lowest level of the hierarchy and are referred to as the entering behaviors; (3) all of the subordinate behaviors between the entering behaviors and the terminal objective(s) which must be learned within the instructional sequence enabling the learner to attain the terminal behavior(s) are called the enabling objectives.

OBJECTIVES

At the end of this learning experience, the participant will have acquired the basic skills necessary for constructing hierarchies. He will:

1. List the four requirements of a terminal objective.

2. Define "construct validity" as one requirement of a terminal objective.

3. Given a set of instructional objectives, correctly identify the terminal objective.

4. Given a hierarchy with the terminal objective missing, construct the terminal objective.

Given a set of objectives and an outline of the schematic with one enabling objective missing, select the missing objective from a given list.

Given a set of objectives and an outline of the schematic with one enabling objective missing, construct the missing objective.

Given a terminal objective, a set of enabling objectives, and an outline of the schematic, order the enabling objectives into a logical hierarchy.

Given a terminal objective and a set of enabling objectives, order them into a logical hierarchy.

Given a terminal objective, a set of enabling objectives (including several which are not necessary for the terminal objective), and a schematic, select the correct objectives and order them into a logical hierarchy.

Given a terminal objective, an incomplete set of enabling objectives, and a schematic, construct the missing objectives.

Construct a terminal objective, do a task analysis, and construct a hierarchy, including the entering behaviors and the enabling objectives. The terminal objective should:

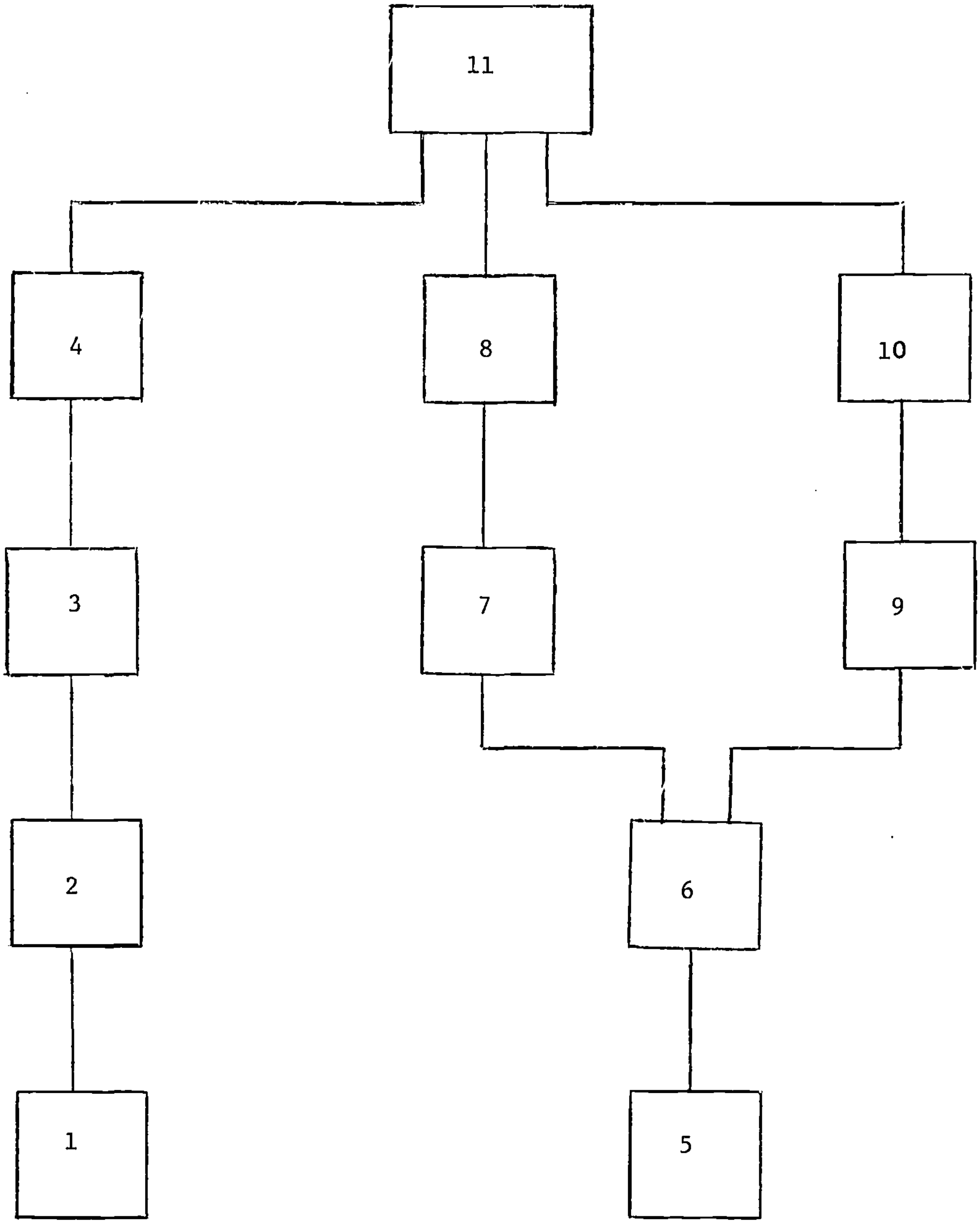
a) Be stated in learner performance.

b) Include minimum acceptable performance.

c) State the conditions under which the behavior will occur.

d) Have "construct validity."

CONSTRUCTING HIERARCHIES - Hierarchy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CONSTRUCTING HIERARCHIES - Suggested Procedures

I. Introduction

A. Provide class with copies of the topic description and objectives.

B. Distribute several examples of hierarchies.

C. Discuss the value and use of hierarchies (see topic description).

II. Instruction and Practice

A. Discuss the techniques used to construct hierarchies.

B. Have each member of the class do Activities 1-10.

C. Check each completed activity and have participants make any necessary corrections before proceeding to the next activity.

III. Application

A. Have each participant construct a hierarchy for his lesson segment.

B. Have a technologist with a knowledge of the subject area or skill check the completed hierarchy and have participants make any necessary revisions.

C. At this point, emphasize that the hierarchy is tentative and may be modified based on new knowledge or experience gained as the participants develop and evaluate the learning module.

IV. Bibliography

A. Gagne, Robert M. The Conditions of Learning. New York: Holt, Rinehart and Winston, Inc., 1965, pp. 149-155.

B. Walbesser, Henry H. Constructing Behavioral Objectives. College Park, Maryland: College of Education, University of Maryland, 1968, pp. 67-89.

CONSTRUCTING HIERARCHIES - Example A

DETERMINING THE LEAST COUNT OF A MEASURING INSTRUMENT

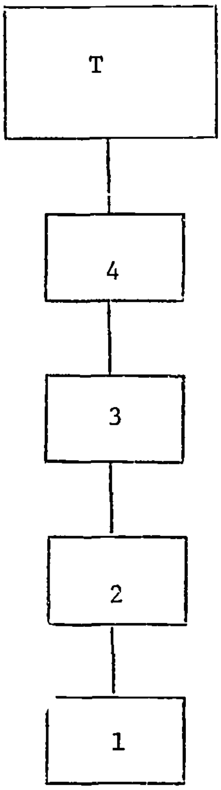
1. Given the smallest division on a uniform linear scale, the student names its least count.

2. Given the term "least count," the student correctly defines "least count," including the terms "smallest," "division," and "uniform scale" or synonymous words.

3. Given a list of three rules including, "divide the value of the smallest labeled unit by the number of subdivisions in that unit," the student will correctly identify the rule for finding least count.

4. The student correctly states, writes, or types the rule for finding the least count including the terms "divide," "unit value" and "number of subdivisions" or synonymous terms.

T. Given a measuring instrument with a uniform linear scale, a "least count" not less than 1/10, and labeling so that only one interpolation is required, or given an illustration of such a measuring instrument, the student will state, write, or type correctly its "least count."



CONSTRUCTING HIERARCHIES - Example B

OBJECTIVES FOR BEGINNING SWIMMING

TERMINAL OBJECTIVES

I. A. The student will jump feet first into water not less than 7 feet deep, float to the surface, level off, and swim 45 feet. Without stopping or touching any support, he will turn around and swim back to his starting point.

I. B. The student will dive from the deck, into water not less than 7 feet deep, level off, and swim the coordinated beginner's stroke 45 feet, turn around, and start swimming back. Halfway back, he will turn on his back and swim the coordinated beginner's back stroke at least 20 feet. He will turn back again to the front swimming position and swim to his starting point.

ENABLING OBJECTIVES

II. A. The student will jump feet first into water not less than 7 feet deep, float to the surface, and swim his way to a horizontal position.

III. A. The student will jump feet first into water not less than 7 feet deep and float to the surface.

III. B. In water of standing depth, the student will push off in a prone position and swim the coordinated beginner's stroke correctly and continuously for a distance of at least 60 feet.

IV. A. In water of standing depth, the student will push off in a prone gliding position and correctly use the beginner's arm and leg strokes, correctly coordinated, to move through the water for a distance of at least 15 feet.

IV. B. In water of standing depth, the student will push off in a prone gliding position, using the beginner's arm stroke to move through the water. In stroke he will make a right turn by reaching to the right with his right arm and turning his head in that direction. He will also make a left turn and make complete turns in both directions.

IV. C. In water of standing depth, the student will push off in a back gliding position and swim at least 30 feet continuously by using correctly finning and the beginner's leg stroke in combination.

V. A. The student will perform correctly a standing front dive from the deck into water not less than chest deep.

V. B. In waist-deep water, the student will push off in a prone gliding position and do the beginner's leg stroke correctly and continuously until he has moved at least four body lengths before resuming a standing position.

CONSTRUCTING HIERARCHIES - Example B (continued)

V. C. In waist-deep water, the student will assume a prone gliding position with his legs trailing or kicking gently and will do the beginner's arm stroke correctly until he has moved at least one body length through the water.

V. D. In waist-deep water, the student will push off in a back gliding position and correctly perform the beginner's leg stroke until he moves at least four body lengths before resuming a standing position.

V. E. In waist-deep water, the student will push off in a back gliding position and fin at least four body lengths through the water.

VI. A. Standing in waist-deep water, the student will bend forward with his arms extended above his head, push his body forward with his legs, take a prone position, glide a distance of at least one body length, and recover to a standing position.

VI. B. The student, in chest-deep water, will turn from a prone floating position to a back floating position and return to a prone float without support and without touching the bottom of the pool.

VI. C. In waist-deep water with his arms at his sides, the student will lower his shoulders beneath the surface, lean back, push off the bottom with his legs, glide a distance of at least one body length on his back with his face above the water, and recover to a standing position.

VII. A. The student will jump feet first from the edge of the pool into chest-deep water.

VII. B. Standing in chest-deep water, the student will alternately inhale through his mouth above the surface and exhale through the mouth and nose with head completely submerged ten times rhythmically and continuously.

VII. C. In waist-deep water, the student will take a prone position on the water and recover to a standing position without assistance or support.

VII. D. The student will assume the back floating position in waist-deep water, hold the position with his face above water for at least ten seconds, and return to a standing position without assistance or support.

VIII. A. The student will completely submerge his entire body in the water for at least three seconds.

ENTERING BEHAVIORS

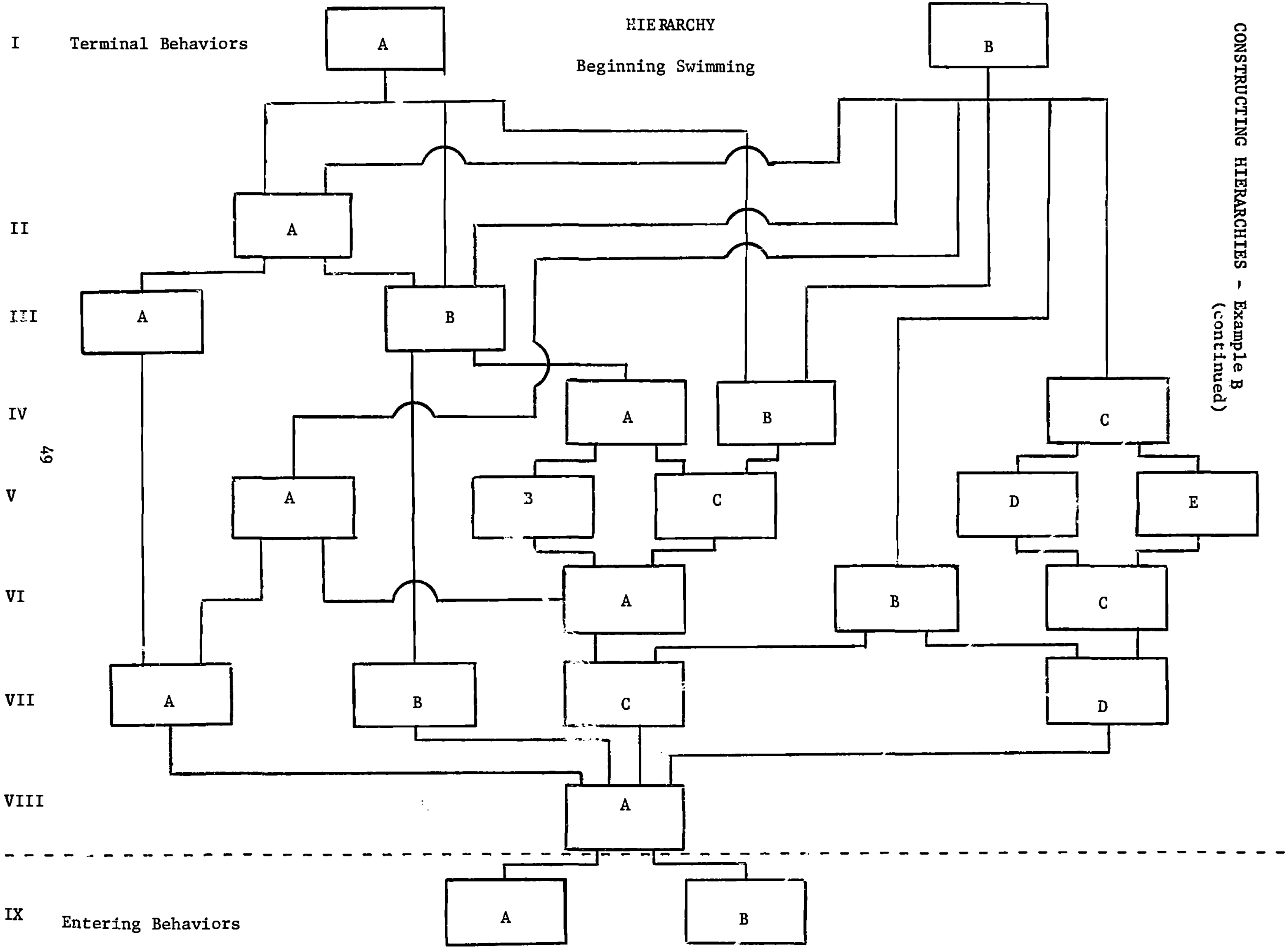
IX. A. The student will stand on the bottom of the pool with his head above the water.

IX. B. The student will hold his breath for at least ten seconds.

CONSTRUCTING HIERARCHIES - Example B
(continued)

HIERARCHY

Beginning Swimming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CONSTRUCTING HIERARCHIES - Example C

LEARNING ABOUT PER CENTS

1. The student will identify the symbol (%) which stands for per cent.

2. Given numbers with the per cent symbol and the word per cent, the student will write the numeral.

3. The student will type or write the symbol for per cent.

4. Given a ratio (n out of 100), the student will write that ratio as a fraction when either the numerator or the denominator (but not both) are missing.

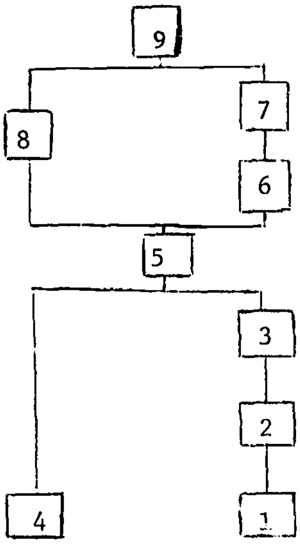
5. Given a fraction with a denominator of 100, the student will write the per cent.

6. Given any integral per cent greater than or equal to 1 per cent and less than or equal to 100 per cent, the student will name the fraction with a denominator of 100.

7. Given any integral per cent equal to or greater than 1 per cent and less than 100 per cent, the student will name the fraction in simplest form.

8. Given fractions with denominators which are factors of 100, the student will write the per cent.

9. Given integral per cents of 100 per cent or less and fractions with denominators of 2, 4, 5, 10, 20, 25, 50 or 100, the student will write the corresponding fraction or per cent.



CONSTRUCTING HIERARCHIES - Example D

SLOPE OF THE LINE

1. When given a linear equation or the graph of a linear equation, name the slope of the line.

2. When given the graph of a linear equation and at least two ordered pairs contained on this graph, determine its slope.

3. When given a linear equation written in the form of Ax + By = C, identify its graph.

4. When given a linear equation written in the form of y = mx + b, identify its graph by using the slope and the y-intercept.

5. When given a linear equation written in the form of Ax + By = C, determine its slope and y-intercept.

6. When given a linear equation, name the slope of the line and y-intercept.

7. When given a linear equation written in the form of y = mx + b, the graph of this equation, and several ordered pairs satisfying this equation, name the relationship which exists between the coefficient of x and the graph of the equation and between the constant and the graph.

8. State a definition for x-intercepts and y-intercepts.

9. When given a linear equation in form y = mx + b or Ax + By = C, determine x when y = 0 and determine y when x = 0.

10. Identify the graph of a linear equation.

11. State a definition of slope.

12. Identify linear equations.

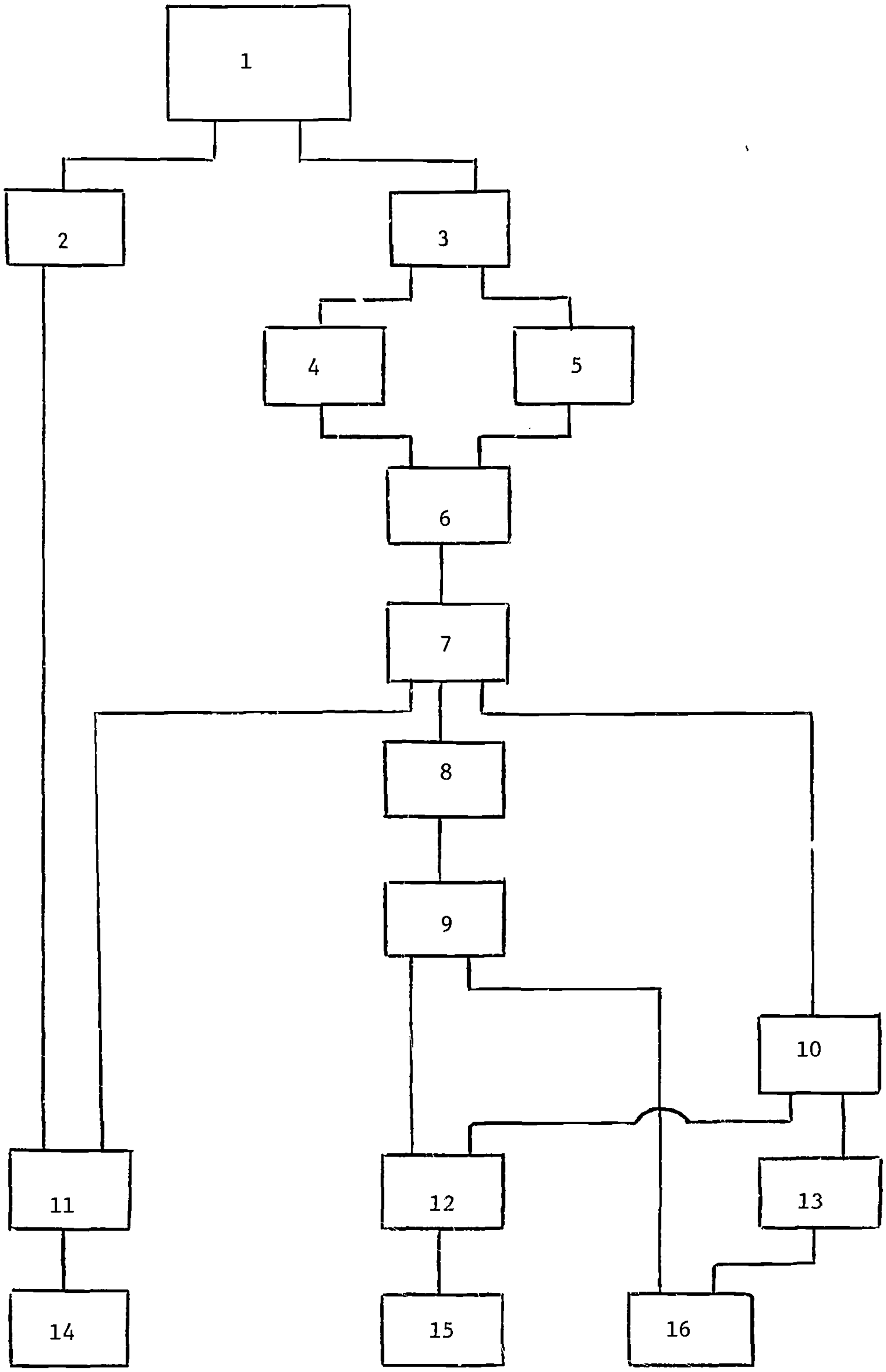
13. When given a linear equation, state that the equation has an infinite number of ordered pairs as solutions and that the graph of these points forms a straight line.

14. When given at least two ordered pairs of a linear equation, name the ratio of the vertical change to horizontal change.

15. State a definition for a linear equation.

16. When given a linear equation and fixed x values, determine the corresponding y values and plot these points on the graph.

CONSTRUCTING HIERARCHIES - Example D (continued)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CONSTRUCTING HIERARCHIES - Activity 1

List the four requirements of a terminal objective.

1. ______________________________

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2. ______________________________

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3. ______________________________

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4. ______________________________

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CONSTRUCTING HIERARCHIES - Activity 2

Define "construct validity" as one requirement of a terminal objective.

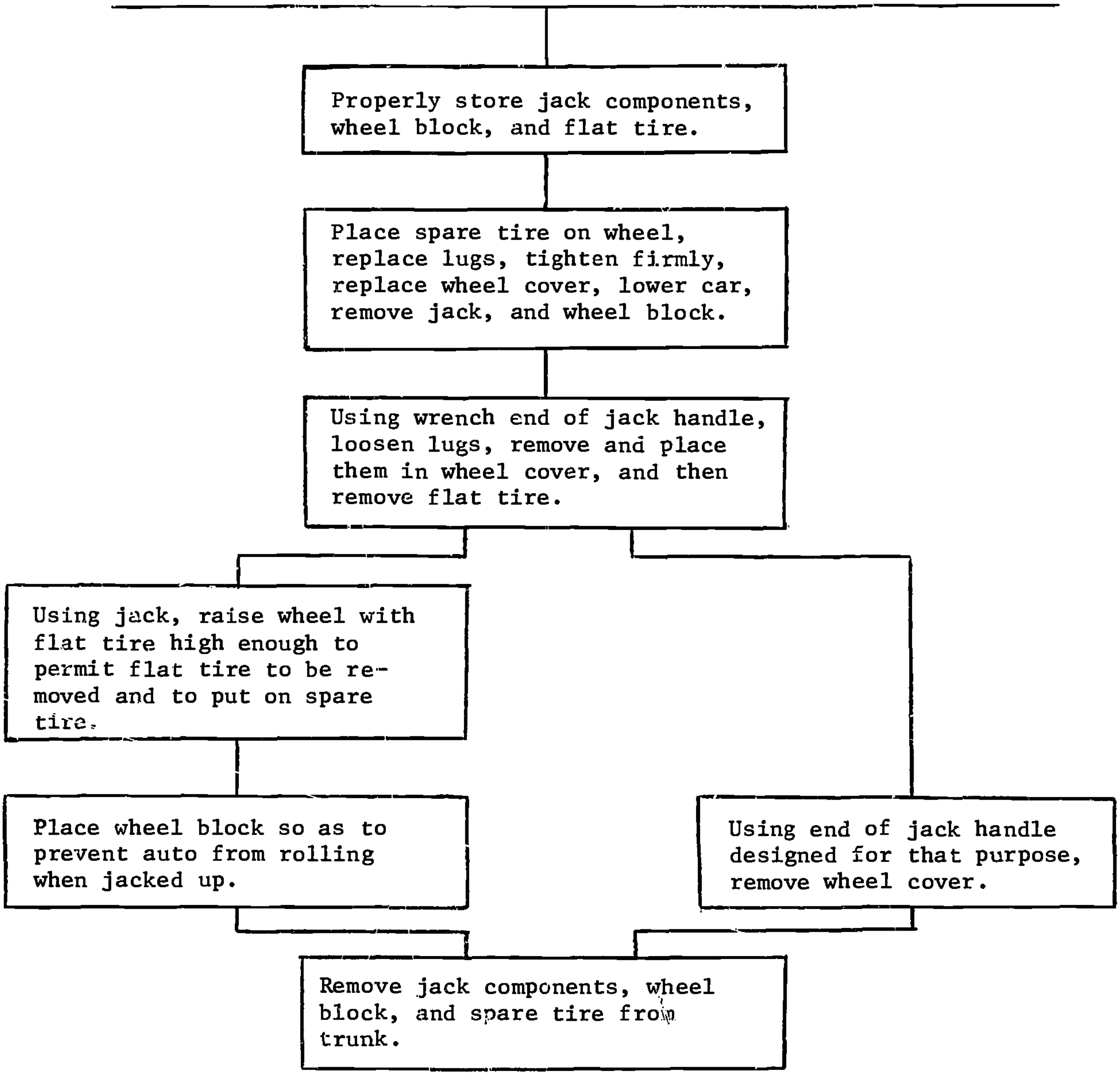
CONSTRUCTING HIERARCHIES - Activity 3

Using the set of objectives below, identify the terminal objective by circling its number.

1. The student will identify whether or not a given written description of a physical situation illustrates combined variation.
2. Given a written description of a physical situation, the student will identify whether or not it illustrates inverse variation.
3. The student will identify whether or not a given written description of a physical situation illustrates variation.
4. Given a written description of a physical situation, the student will identify whether or not it illustrates direct variation.
5. Given ten written descriptions of physical situations, the student will correctly identify at least nine as to the type of variation.
6. The student will identify whether or not a given written description of a physical situation illustrates joint variation.

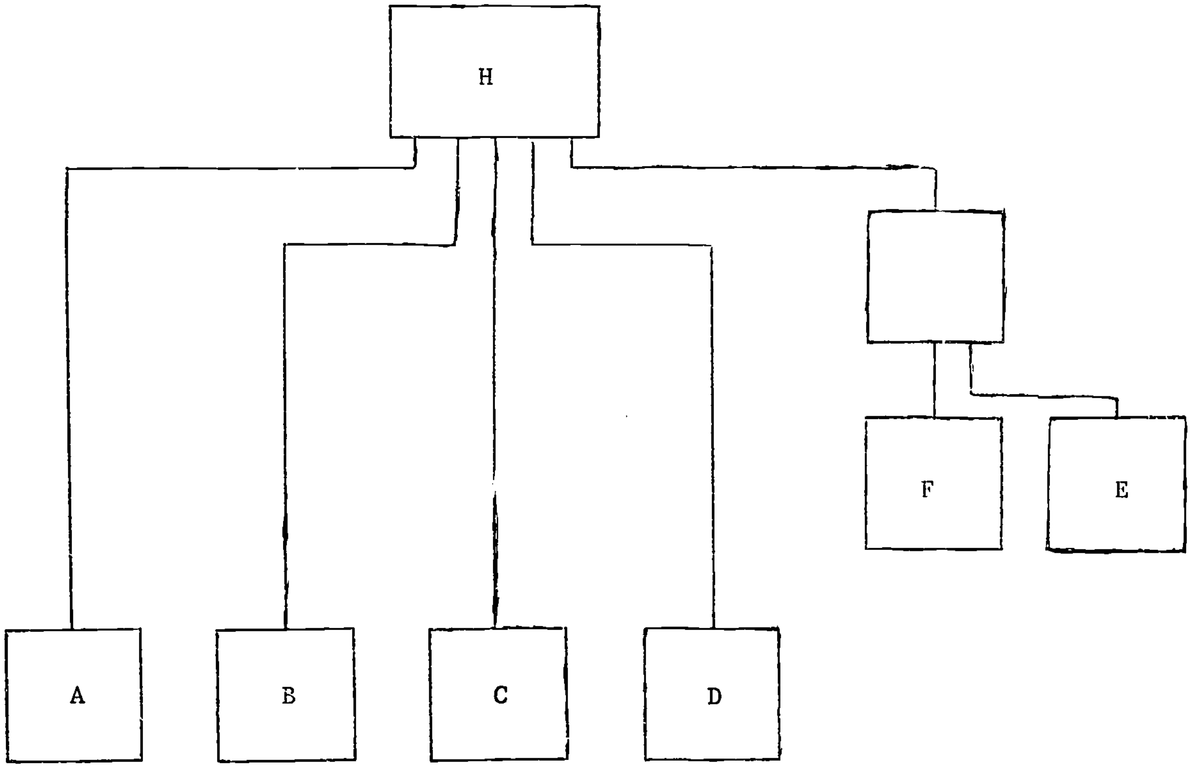
CONSTRUCTING HIERARCHIES - Activity 4

Write the terminal objective for the hierarchy on "changing a flat tire" below.


Properly store jack components, wheel block, and flat tire.
Place spare tire on wheel, replace lugs, tighten firmly, replace wheel cover, lower car, remove jack, and wheel block.
Using wrench end of jack handle, loosen lugs, remove and place them in wheel cover, and then remove flat tire.
Using jack, raise wheel with flat tire high enough to permit flat tire to be removed and to put on spare tire.
Place wheel block so as to prevent auto from rolling when jacked up.
Using end of jack handle designed for that purpose, remove wheel cover.
Remove jack components, wheel block, and spare tire from trunk.

CONSTRUCTING HIERARCHIES - Activity 5

Below is a schematic of a hierarchy and the objectives on the construction of a model methane molecule with one enabling objective missing. From the list provided, select the enabling objective which correctly completes the hierarchy. Write the number of the objective in the empty box on the schematic.



A. Given a molecular model kit, identify which color wooden ball represents the carbon atom.

B. Given a molecular model kit, identify which color wooden ball represents the hydrogen atom.

C. Given a molecular model kit, distinguish between the use of the long wooden pegs and the short ones in constructing molecular models.

D. Given a molecular model kit, state that the number of holes in the wooden balls is equal to the oxidation number or valence of an element.

E. Define a hydrocarbon.

F. Given three molecular models, one having a single bond, one a double bond, and one a triple bond, distinguish among a single, double, and triple bond.

H. Given a wooden ball representing a carbon atom and instructions to saturate it with models of the hydrogen atom, construct the methane molecular model with parts from the molecular model kit.

Select one of the following objectives to complete the hierarchy on the construction of a model methane molecule:

G-1. Given a model of the methane molecule, name it methane.

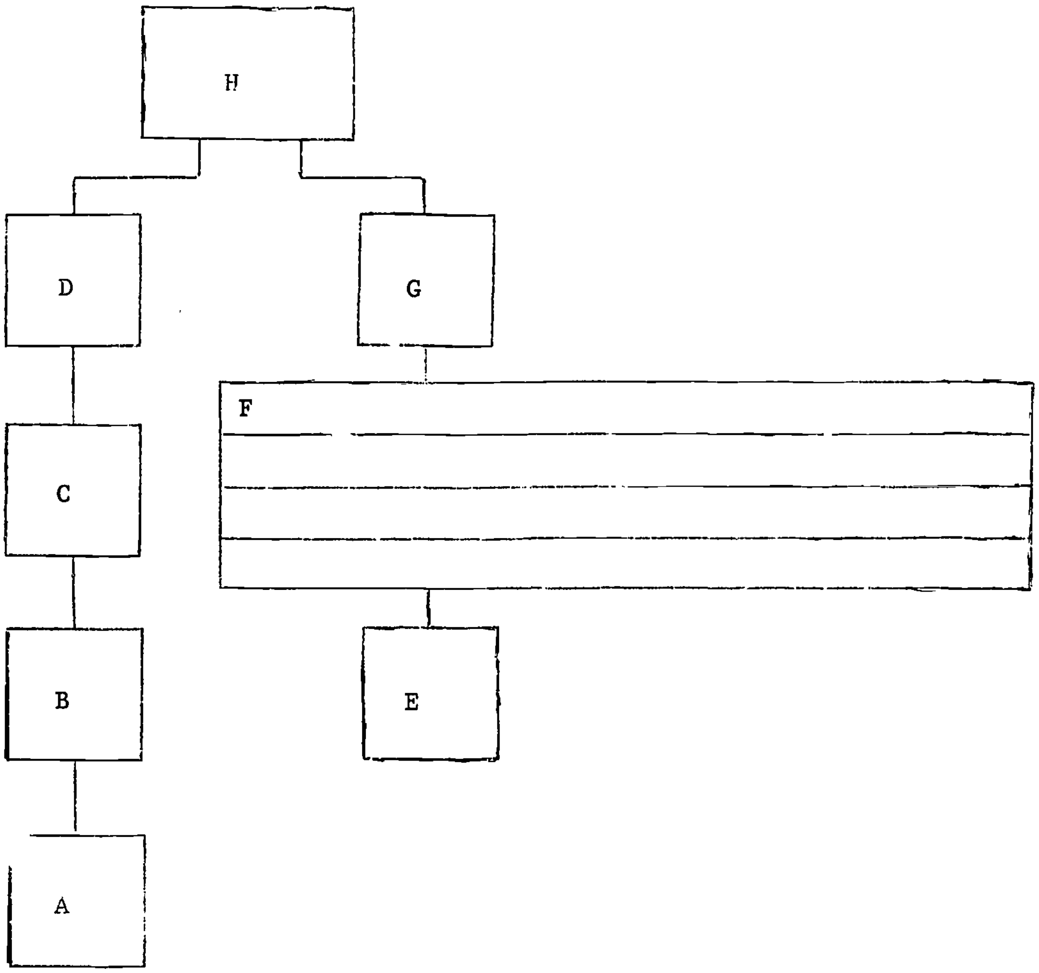
G-2. Define a saturated hydrocarbon as one that has only single bonds between the carbon atoms or one which has all of its bonds satisfied.

G-3. Given two wooden balls representing carbon atoms and instructions to saturate then with models of hydrogen atoms, construct the ethane molecular model with the model kit.

G-4. Name saturated hydrocarbons as alkanes.

CONSTRUCTING HIERARCHIES - Activity 6

Construct the missing objective (F) in the space provided in the hierarchy below.



A. Name correctly the ratio of the greatest possible error in a measurement to the measurement itself as relative error.

B. Given a list of four methods or formulas for finding relative error (three incorrect and one correct), identify the correct method or formula.

C. State a correct rule for finding relative error in a linear measurement.

D. Given the greatest possible error of a linear measuring instrument and a measurement in the same units made with the instrument, correctly calculate the relative error.

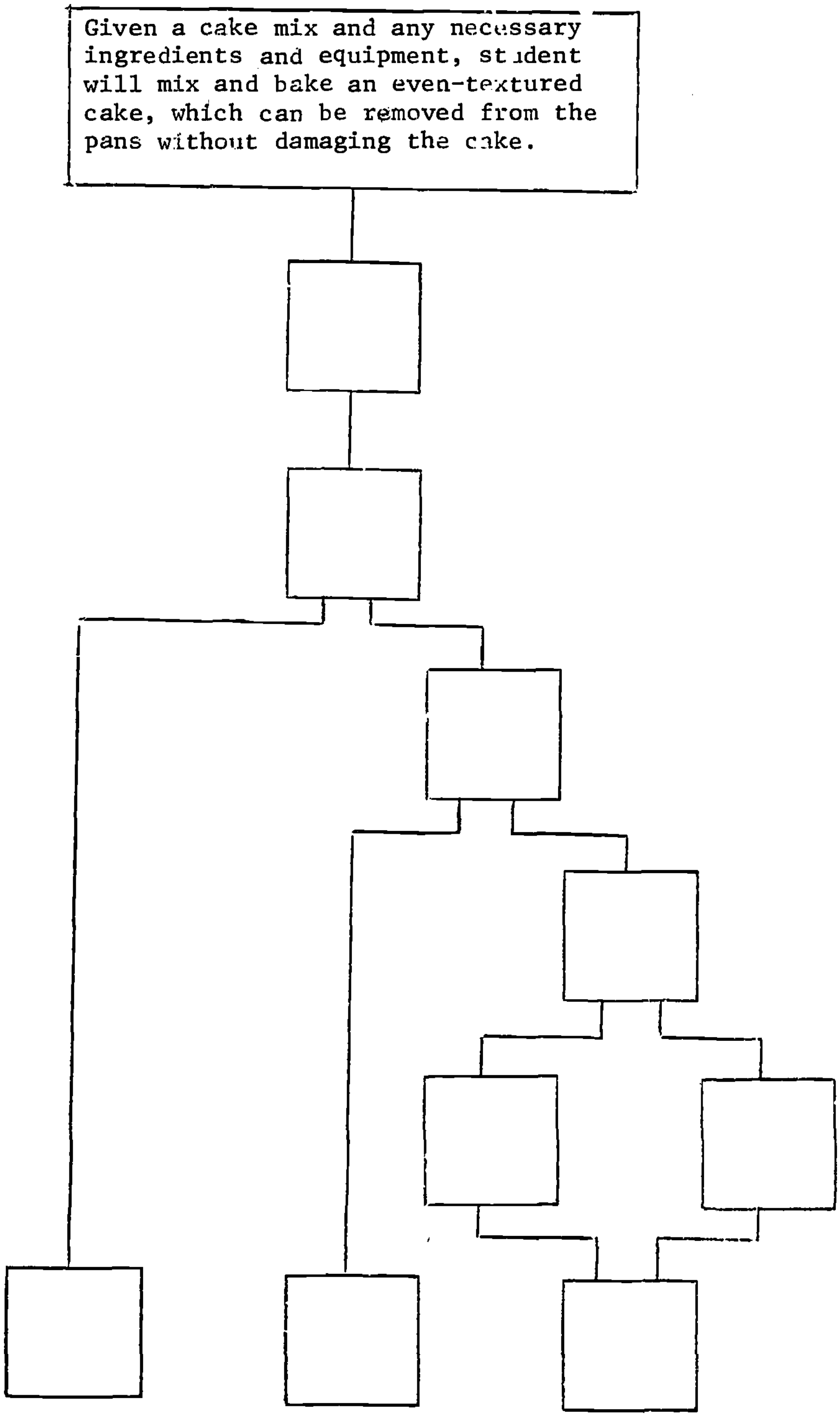
E. Given a list of four methods or formulas for finding the greatest possible error (three incorrect and one correct), identify the correct method or formula.

G. Given the least count of a linear measuring instrument, correctly calculate the greatest possible error.

H. Given the least count of a linear measuring instrument and a measurement in the same units made with the instrument, correctly calculate the relative error.

CONSTRUCTING HIERARCHIES - Activity 7

Arrange the enabling objectives provided in a logical hierarchy, and write the number of each objective in the correct box in the schematic below.



Given a cake mix and any necessary ingredients and equipment, student will mix and bake an even-textured cake, which can be removed from the pans without damaging the cake.

CONSTRUCTING HIERARCHIES - Activity 7 (continued)

1
Place equal amounts of batter into two greased and floured pans and distribute evenly in each pan.

2
Open box and place cake mix in mixing bowl.

3
When automatic timer signals, remove baked cake and turn off oven.

4
Turn on baking unit and set control for proper baking temperature.

5
Given two cake pans, grease entire inside surfaces without any visible excess and place approximately 1 tablespoon flour in each pan, shake and coat pans with flour, and dump out excess.

6
When baking unit reaches proper temperature, place pans containing batter in unit and set timer for prescribed baking time.

7
Measure liquid ingredients into bowl with cake mix.

8
Using electric mixer, mix ingredients until there are no lumps or flour visible.

9
Measure any necessary dry ingredients into bowl with cake mix.

CONSTRUCTING HIERARCHIES - Activity 8

The terminal objective for an instructional segment on polygons is written below. Order the enabling objectives provided into a logical learning sequence and construct a schematic illustrating the hierarchy in the space below. (Numbers are for identification purposes only and are not related to location in the hierarchy.)

> Given five polygons (made up of three, four or five line segments), the student will name each one as a triangle, quadrilateral or pentagon.

CONSTRUCTING HIERARCHIES - Activity 8 (continued)

1
Given four polygons, the student will identify and name a triangle.

2
Given four open and closed simple shapes the student will identify the simple closed curves.

3
Given four simple curves, the student will distinguish between those shapes which are open and those which are closed.

4
Given four polygons, the student will identify and name a quadrilateral.

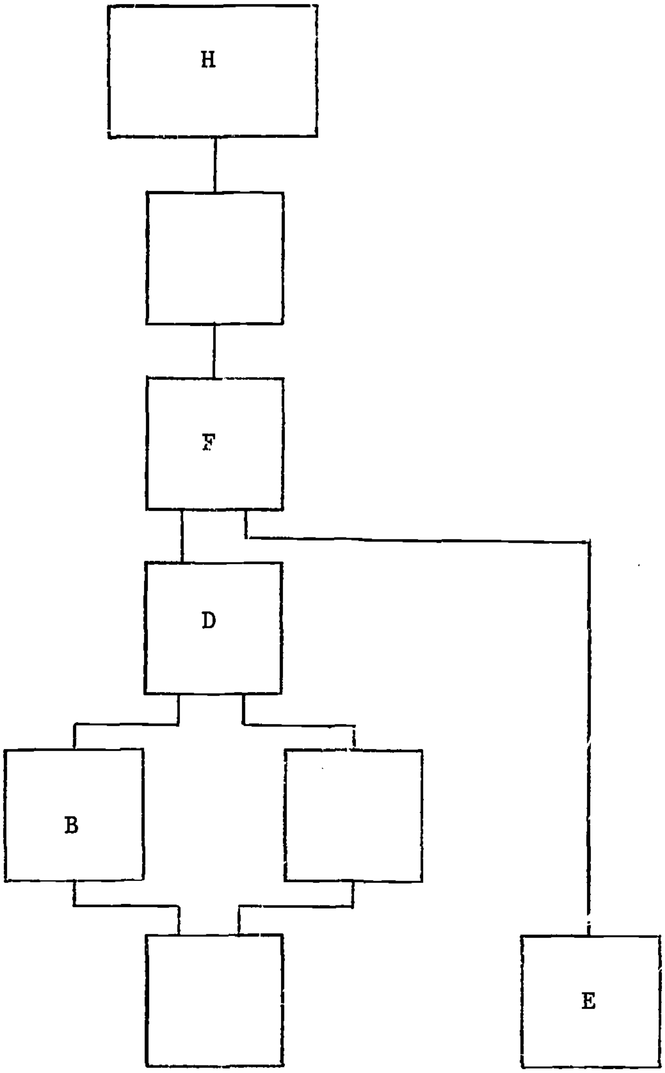
5
Given four simple closed curves presented individually, the student will identify the simple closed curves made up of line segments as pologons.

6
Given four polygons, the student will identify and name a pentagon.

7
Given four open and closed simple shapes, the student will identify the open simple curves.

CONSTRUCTING HIERARCHIES - Activity 9

Below is a schematic of a hierarchy, the terminal objective, and some of the enabling objectives. From the list provided select the enabling objectives which correctly complete the hierarchy. Write the numbers of the selected objectives in the empty boxes on the schematic.



B. Given a vernier caliper, identify the fixed or parent scale.

D. Given a vernier caliper, distinguish between the vernier and the fixed or parent scale.

E. Given a vernier caliper with metric and English scales, distinguish one from the other.

F. Given a vernier caliper, count the spaces on the metric parent or fixed scale which occupy the same amount of space as the 10 metric divisions on the vernier scale.

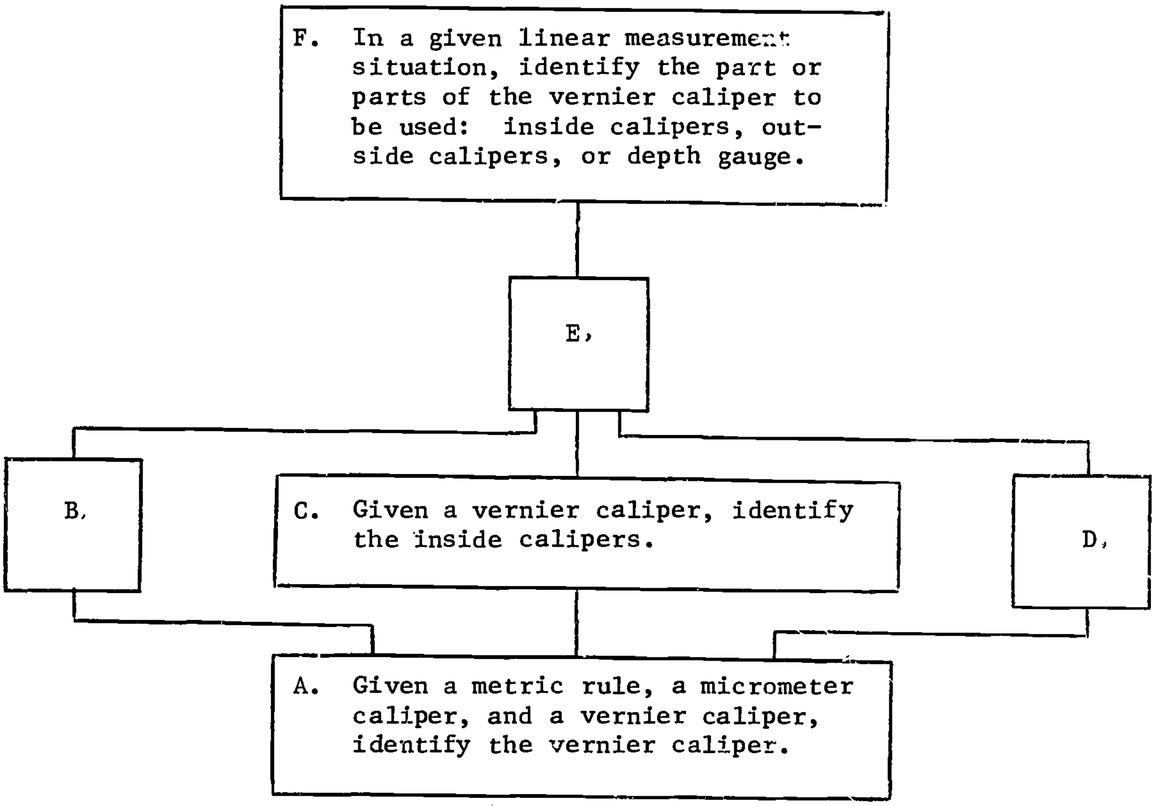
H. Given a vernier caliper, state its metric least count or precision.

Select three of the following enabling objectives to complete the hierarchy for Activity 9.

1. Given a vernier caliper, describe the metric relationship of the vernier scale to the fixed scale.
2. Given a hollow metal cylinder, correctly identify a diameter.
3. Given a metric rule, a micrometer caliper, and a vernier caliper, identify the vernier caliper.
4. Given a vernier caliper, properly adjust it to make a measurement of outside dimensions.
5. Given a vernier caliper, distinguish among the inside calipers, the outside calipers, and the depth gauge.
6. Given a vernier caliper, identify the vernier scale.

CONSTRUCTING HIERARCHIES - Activity 10

Construct the missing objectives (B, D, and E) in the spaces provided below.



F. In a given linear measurement situation, identify the part or parts of the vernier caliper to be used: inside calipers, outside calipers, or depth gauge.

C. Given a vernier caliper, identify the inside calipers.

A. Given a metric rule, a micrometer caliper, and a vernier caliper, identify the vernier caliper.

B. ______________________________

D. ______________________________

E. ______________________________

F. TYPES OF TESTS

Traditionally, tests have been used by classroom teachers for comparing the performance of one student with that of the class for the purpose of assigning a letter or numerical grade. In an individualized environment, however, testing is a tool for improving the learning materials and methods, designing the best possible instructional program for each individual student, and determining the student's progress toward the attainment of specific instructional objectives.

The basic guide for the construction of all the tests utilized with an Individualized Learning Module is the learning hierarchy. Once the hierarchy is completed, criterion test items are written for each objective, including the entering behaviors. A criterion (or assessment) test item measures whether or not an individual has acquired the specific behavior(s) described in an instructional objective. These items are employed individually within the instructional sequence for assessing the attainment of specific objectives. In addition, they may be arranged in the form of entering behaviors tests, pretests, posttests, and diagnostic tests.

The types of tests which may be used with an Individualized Learning Module are defined as follows:

1. An entering behaviors test determines if a student has the behaviors necessary to be successful in a specific instructional program.

2. A pretest determines if a student has the terminal behaviors(s) for a specific instructional program so a decision may be made as to whether or not he needs the program.

3. A posttest determines if a student has the terminal behavior(s) after completing an instructional program.

4. A diagnostic test determines the point(s) at which a student could enter an instructional program.

OBJECTIVES

At the end of this learning experience, the participant will demonstrate a knowledge of and skill in constructing tests for an Individualized Learning Module. He will:

1. Define a criterion test item.

2. Name and define the four types of tests used with Individualized Learning Modules.

3. Define validity and reliability as they apply to testing.

4. Construct the criterion items for a specific instructional sequence.

5. Construct an entering behaviors test for a specific instructional sequence.

6. Construct a pretest and/or posttest for a specific instructional sequence.

PART III

DEVELOPING AN INDIVIDUALIZED LEARNING MODULE

The hierarchy and criterion test items form the basic structure upon which the instructional sequence of the module is built. Where designing the lesson segment involved nearly all technique, the development of effective learning activities requires some degree of imagination and creativity. The completion of this stage includes the accomplishment and documentation of the following steps:

1. Devising and flowcharting the instructional strategy.
2. Selecting the presentation media.
3. Writing the instructional sequence.
4. Editing the draft and translating it to the presentation media.
5. Testing the module with a small group of students from the target population.
6. Revising the module based on feedback from the student tryout.

Documentation for this state consists of the instructional strategy flowchart, the factors affecting media selection, the module draft, all data from the pilot test, and the revised version of the module.

A. FLOWCHARTING

A flowchart provides a graphic description of the instructional strategy for a lesson segment. During the developmental stage, a flowchart helps the author visualize the sequence of material and the relationship of one part of the lesson to another. It serves as a means of experimenting with various strategy designs and of insuring that all conditions which could arise during the program are satisfied. The completed flowchart serves as a guide for writing and editing the instructional sequence. It also provides the potential user (teacher) with a clear picture of the strategy of the lesson segment.

RULES FOR FLOWCHARTING

1. Flowlines connect the various symbols in a flowchart. These lines should not cross each other.
2. Arrowheads indicate the flow direction and are located on the flowlines at their points of entry to symbols.
3. The general direction of flow is from top to bottom for the main line and from left to right for the branching lines.

SUGGESTED PROCEDURES FOR FLOWCHARTING

1. Begin by tentatively laying out, first, the main line and second, the branching lines of the basic flowchart.
2. Trace every path through the flowchart to insure that provision has been made for all possible conditions.

3. The flowchart may have to be reworked several times before it accurately describes the instructional strategy in a clear, concise manner.

4. Construct any additional flowcharts necessary to detail operations indicated but not described on the basic chart.

OBJECTIVES

At the end of this learning experience the participant will:

1. Given a simple flowchart, follow its logic.

2. Given the seven basic flowcharting symbols and a list containing a description of the function of each, match the description with the correct symbol.

3. Given the seven basic symbols, correctly describe the function of each in a flowchart.

4. Given the function of the seven basic flowcharting symbols, draw each one.

5. Draw the seven basic flowcharting symbols and describe the function of each.

6. Given a flowchart with all necessary statements and arrows, draw the appropriate basic symbols.

7. Given general guidelines for flowcharting and a chart with all necessary symbols and statements, draw the arrows.

8. State the three rules for flowcharting.

9. Given a short routine with clearly defined steps, construct a flowchart.

10. Given a familiar routine, construct a flowchart which defines the specific steps and the flow necessary to accomplish the routine.

11. Given a word description of an instructional strategy, flowchart it.

FLOWCHARTING - Suggested Procedures

I. Introduction

   A. Provide the group with copies of the topic description and objectives including the page entitled, "Basic Flowcharting Symbols."

   B. Use several flowcharts from the topic on Instructional Strategies as examples

II. Instruction and Practice

   A. Discuss the value and use of flowcharts as well as the basic techniques employed.

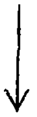
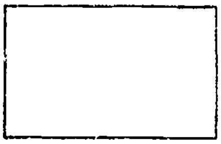
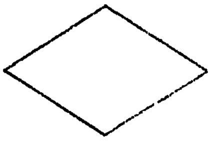
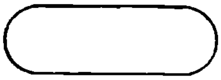
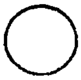
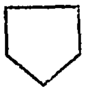
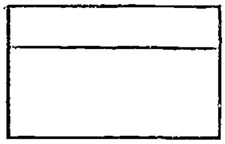
   B. Emphasize that there is no one correct way to flowchart a given problem or instructional strategy.

   C. Have the participants work through activities 1-11.

   D. Check each completed activity and have the individual participant make any necessary corrections before proceeding to the next activity.

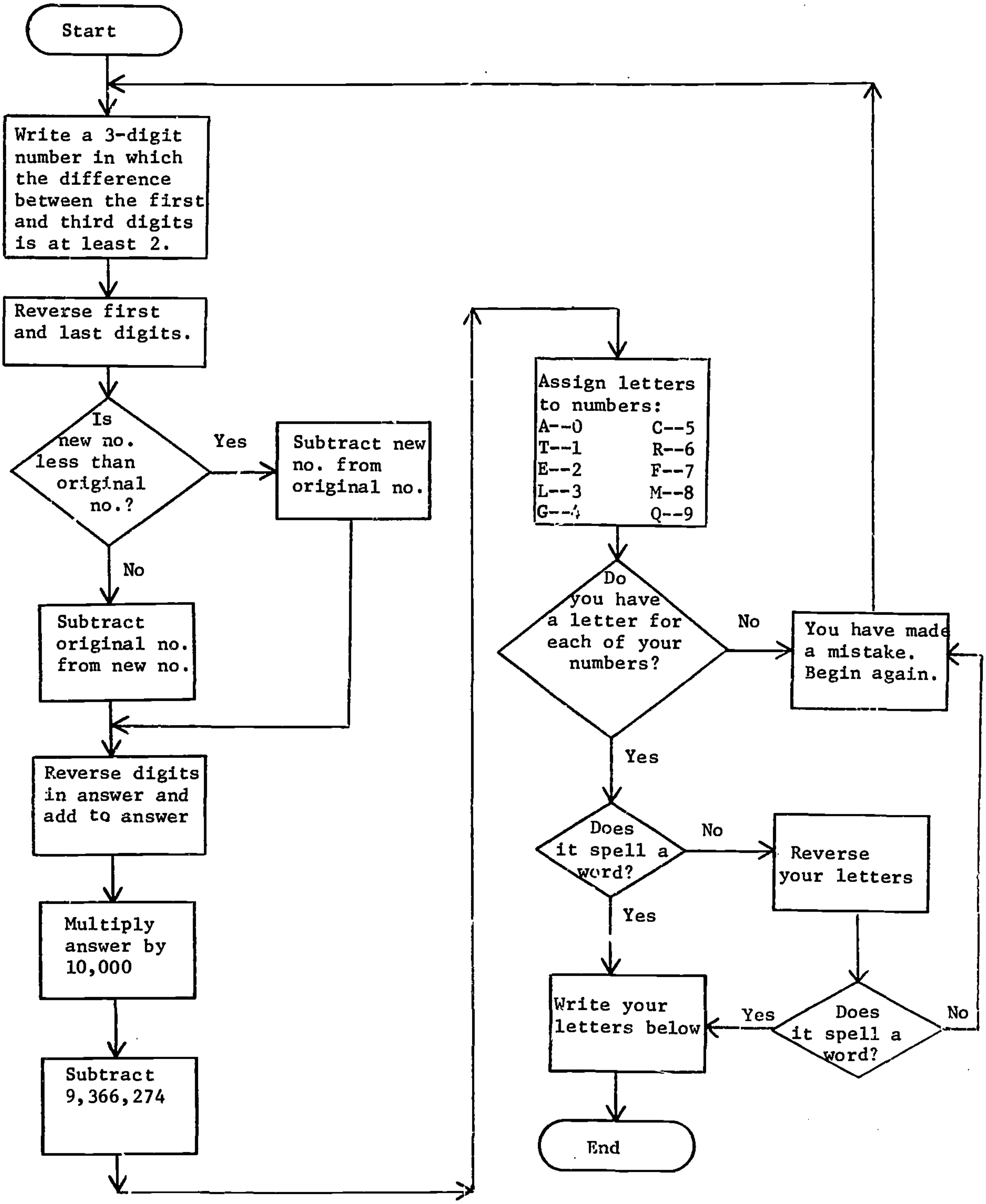
III. Application--See Instructional Strategy Objective.

BASIC FLOWCHARTING SYMBOLS

	Flowline and Arrowhead	Operation sequence and flow direction
	Process	General processing functions not represented by other symbols
	Decision	A point in a program at which a branch to one of two or more alternate paths is possible
	Terminal	Any point at which a program begins or ends
	Connector	Entry from or exit to another part of the flowchart
	Offpage Connector	Exit from or entry to a page
	Striped Symbol	An operation detailed elsewhere in this same set of flowcharts

FLOWCHARTING - Activity 1

Follow the instructions in the flowchart below.


Start
Write a 3-digit number in which the difference between the first and third digits is at least 2.
Reverse first and last digits.
Is new no. less than original no.?
Yes
Subtract new no. from original no.
No
Subtract original no. from new no.
Reverse digits in answer and add to answer
Multiply answer by 10,000
Subtract 9,366,274
Assign letters to numbers:
A--0
T--1
E--2
L--3
G--4
C--5
R--6
F--7
M--8
Q--9
Do you have a letter for each of your numbers?
No
You have made a mistake. Begin again.
Yes
Does it spell a word?
No
Reverse your letters
Yes
Write your letters below
Does it spell a word?
Yes
No
End

FLOWCHARTING - Activity 2

Match the description of the function of each symbol within a flowchart with the correct symbol by placing the letter of the symbol on the line next to the appropriate description.

_________ 1. Operation sequence and flow direction.

_________ 2. General processing functions not represented by other symbols.

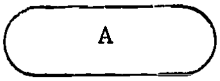
_________ 3. A point in the program at which a branch to one of two or more alternate paths is possible.

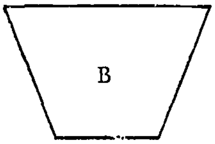
_________ 4. Any point at which a program begins or ends.

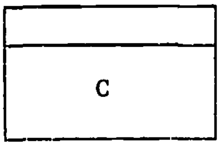
_________ 5. Entry from or exit to another part of the flowchart.

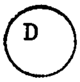
_________ 6. Exit from or entry to a page.

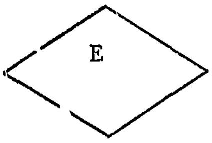
_________ 7. An operation detailed elsewhere in this same set of flowcharts.

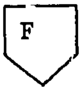

A


B


C


D


E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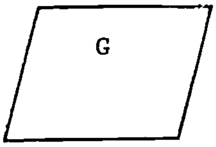
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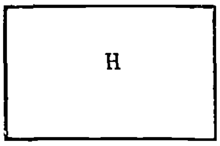
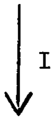
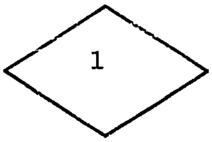

H


I

FLOWCHARTING - Activity 3

Describe the function of each of the flowcharting symbols below.



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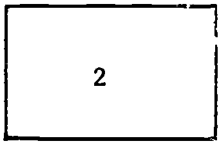

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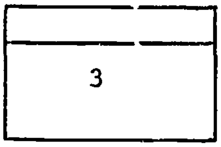

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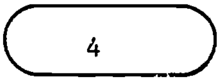

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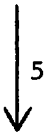

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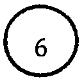

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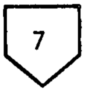


____

____

FLOWCHARTING - Activity 4

To the right of each of the descriptions below, draw the flowcharting symbol which represents the description.

Description	Symbol
1. Entry from or exit to another part of the flowchart.	
2. General processing functions not represented by other symbols.	
3. An operation detailed elsewhere in this same set of flowcharts.	
4. Exit from or entry to a page.	
5. Operation sequence and flow direction.	
6. A point in a program at which a branch to one of two or more alternate paths is possible.	
7. Any point at which a program begins or ends.	

FLOWCHARTING - Activity 5

Draw the seven symbols used for flowcharting instructional strategies and describe the function of each.

Symbol Description

1.

2.

3.

4.

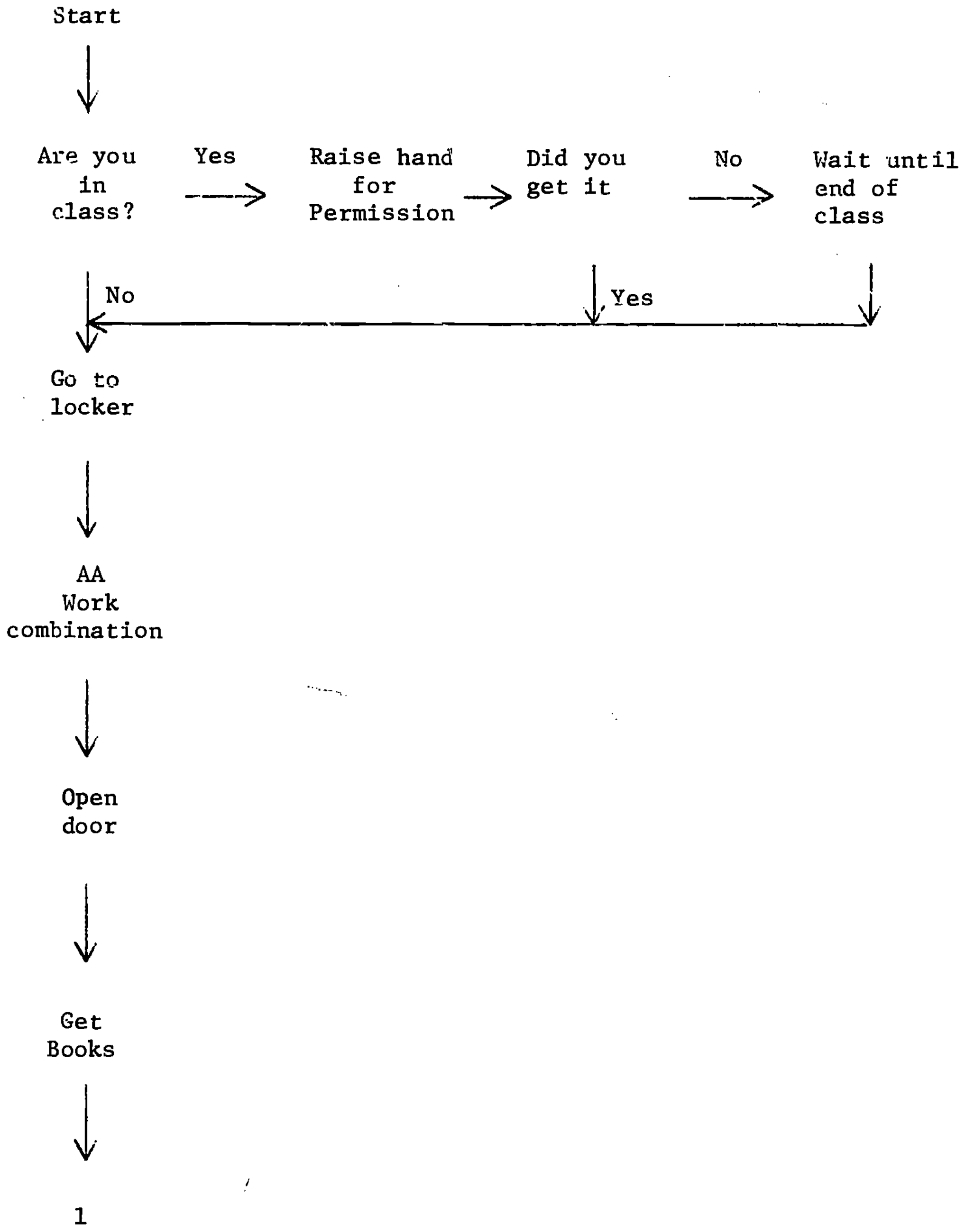
5.

6.

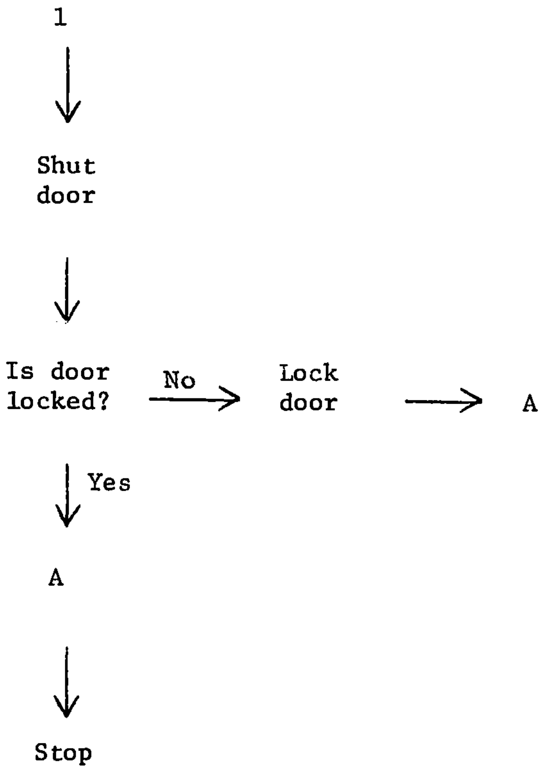
7.

FLOWCHARTING - Activity 6

Draw the appropriate symbols on the following flowchart:

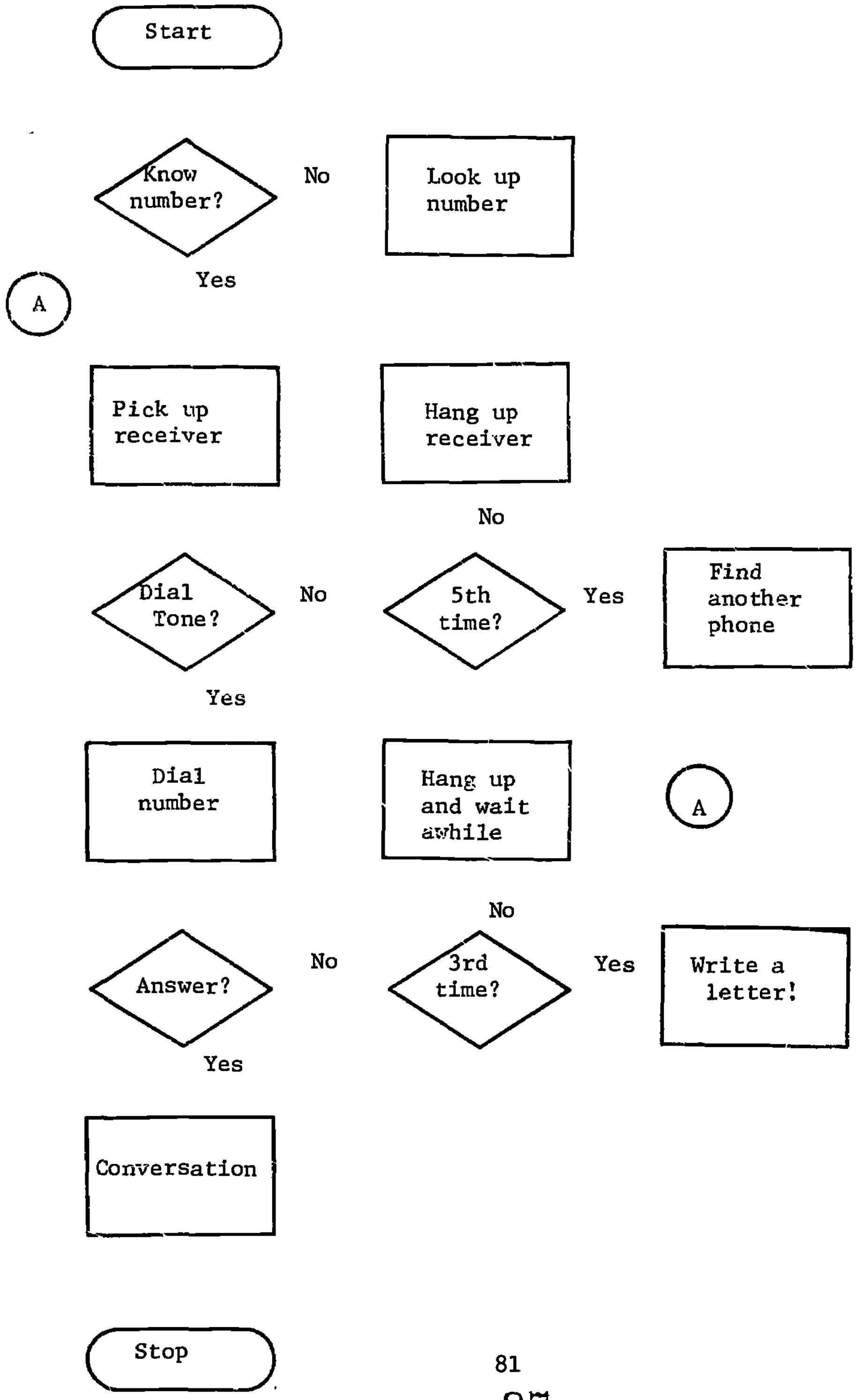

Start
Are you in class?
Yes
Raise hand for Permission
Did you get it
No
Wait until end of class
No
Yes
Go to locker
AA Work combination
Open door
Get Books
1

FLOWCHARTING - Activity 6 (continued)


1
Shut door
Is door locked?
No
Lock door
A
Yes
A
Stop

FLOWCHARTING - Activity 7

Draw in the flowlines and arrowheads on the flowchart below.


Start
Know number?
No
Look up number
Yes
A
Pick up receiver
Hang up receiver
No
Dial Tone?
No
5th time?
Yes
Find another phone
Yes
Dial number
Hang up and wait awhile
A
No
Answer?
No
3rd time?
Yes
Write a letter!
Yes
Conversation
Stop

FLOWCHARTING - Activity 8

State the three rules for flowcharting.

1. ______________________________

2. ______________________________

3. ______________________________

FLOWCHARTING - Activity 9

In the space below, construct a flowchart to illustrate this problem statement:

> You have just received your monthly checking account statement. Check the balance; if yours agrees with the bank, put it away. If not in agreement, check in order -- deposits, checks written, arithmetic involved, and correct any errors. If your records still do not agree with those of the bank after three attempts to find an error, take the statement and your records to the bank.

FLOWCHARTING - Activity 10

Construct a flowchart illustrating a turn taken by a player in the Game of Monopoly.

The purpose of the Game of Monopoly is to buy and rent or sell properties in order to become the wealthiest player and winner. Starting from "Go" the player moves his token around the board according to throw of dice. Each time he passes "Go" he collects $200.00 from the bank. If he lands on property owned by someone else, he must pay rent. If the property is not owned, the player may purchase it from the bank. If the player throws doubles, he takes his turn and then throws the dice for a second move within the same turn. However, if doubles are thrown three consecutive times, the player goes to jail.

FLOWCHARTING - Activity 11

Flowchart the survey test strategy described below.

This is a series of four survey tests to determine whether the student has attained the terminal objective in each of the four arithmetic operations in whole numbers. Starting with addition, the student is presented five problems. If he does four of the five correctly, the student will go to the next survey test. He will continue until he has completed all four and then stop. In order to prevent the student from becoming frustrated by problems which may be too difficult, as soon as he does any two problems incorrectly, he is branched into a diagnostic test.

B. INSTRUCTIONAL STRATEGIES

An instructional strategy is a general plan devised by the author of a lesson segment to ensure the student's progress toward the acquisition of the terminal objective(s). This plan specifies the sequence of instruction, the conditions which may modify the lesson flow, and any options available to the individual student.

Since the instructional strategy supplies the basic conceptual framework for developing the learning sequence, it is essential that it be carefully devised. The characteristics of the target population, the type of learning implied in the objectives, the instructional technique(s) to be employed, and the capabilities or limitations of the presentation medium should be considered in the design.

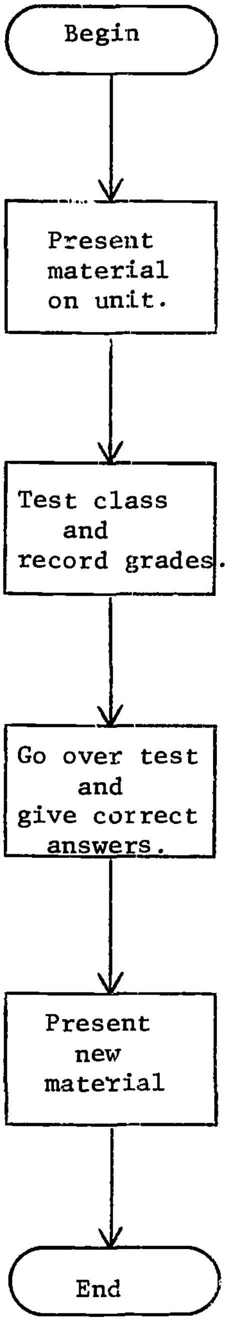
Instructional strategies range from simple linear plans to those which involve complex branching and include an infinite number of possibilities. Since there are no specific skills which will help the author devise a successful strategy, a number of examples have been provided and the rest is left to the imagination and creativity of the individual author.

OBJECTIVE

Devise and flowchart an instructional strategy for an Individualized Learning Module.

INSTRUCTIONAL STRATEGY - Example A

A Classroom Strategy


Begin
Present material on unit.
Test class and record grades.
Go over test and give correct answers.
Present new material
End

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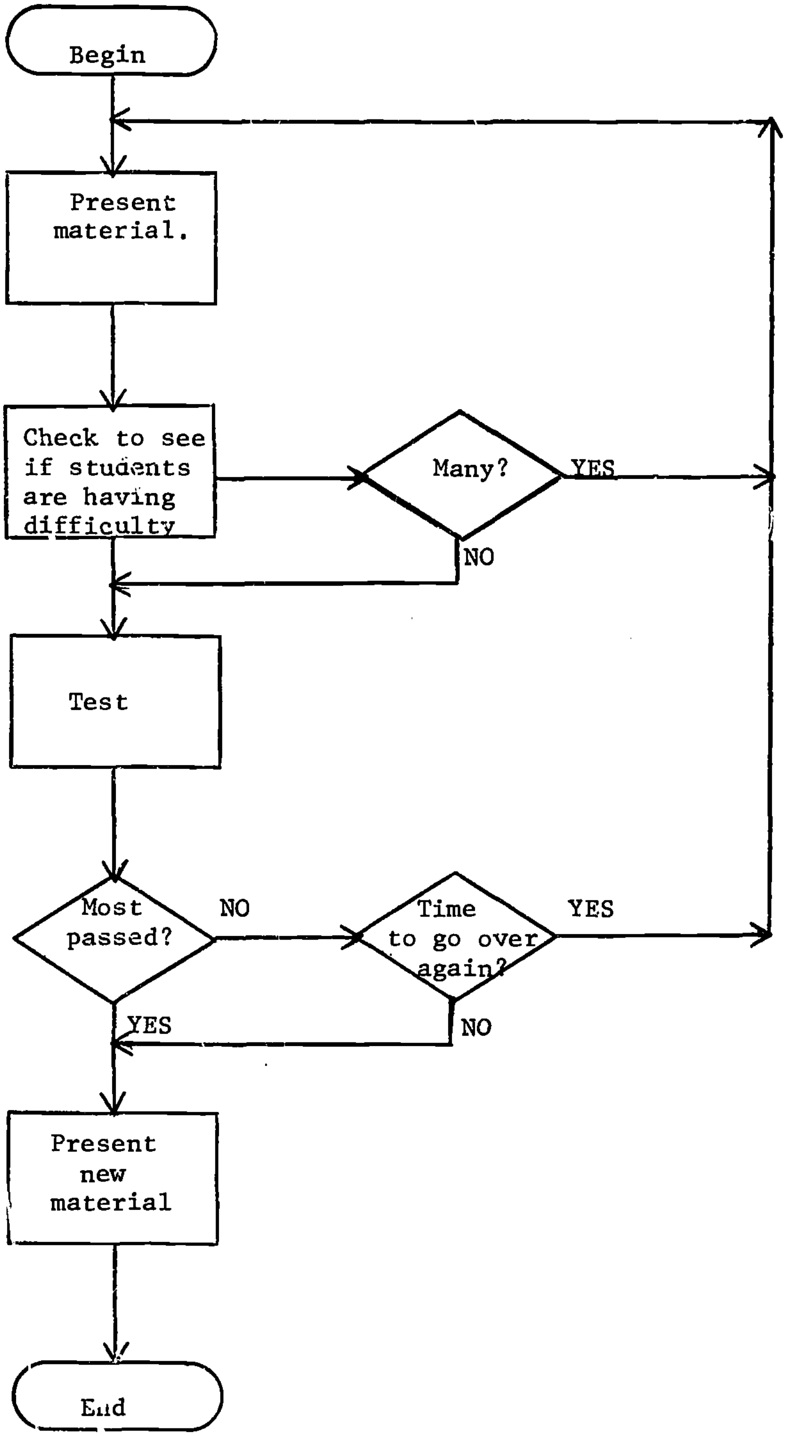
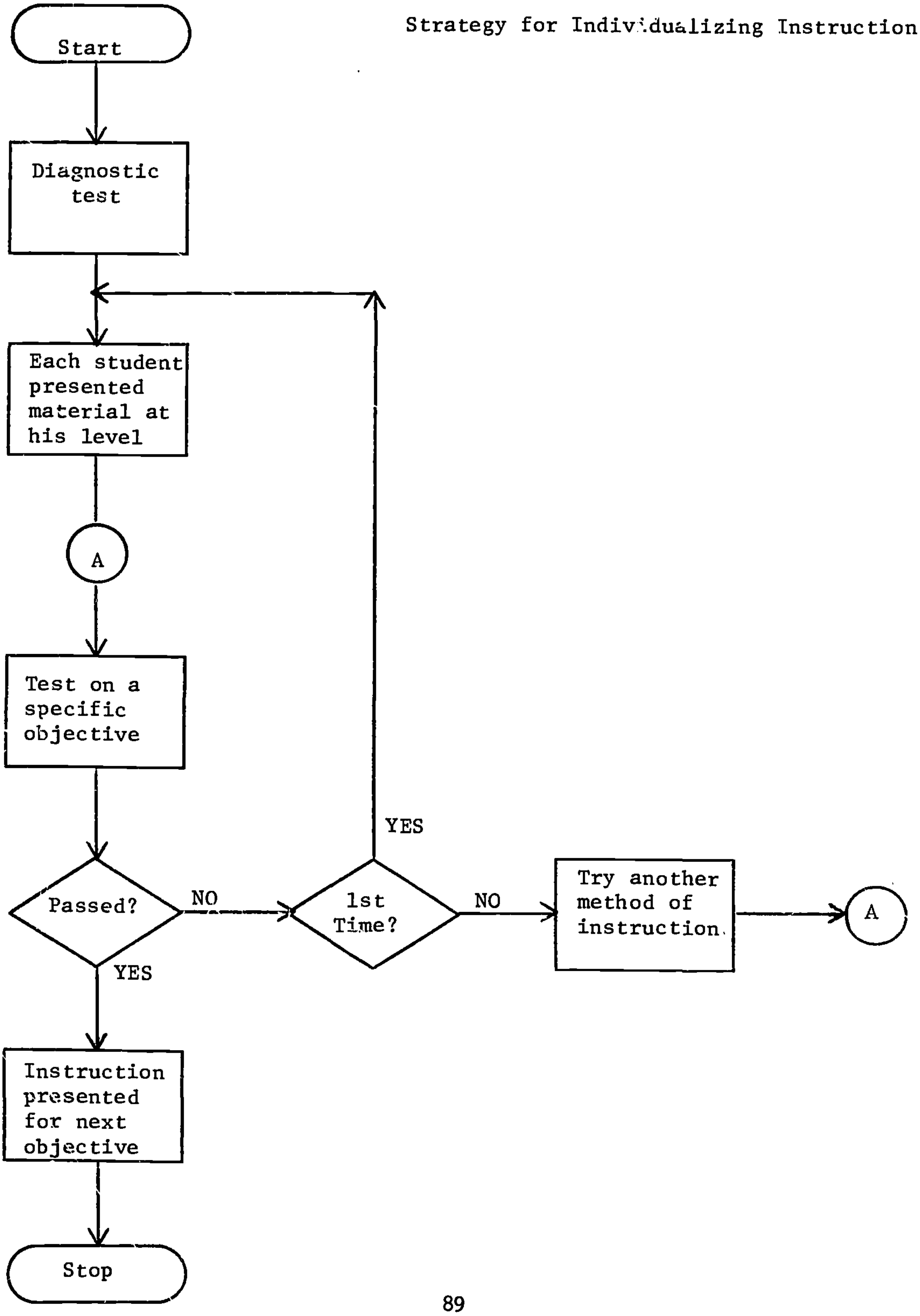
INSTRUCTIONAL STRATEGY - Example 3

A Classroom Strategy

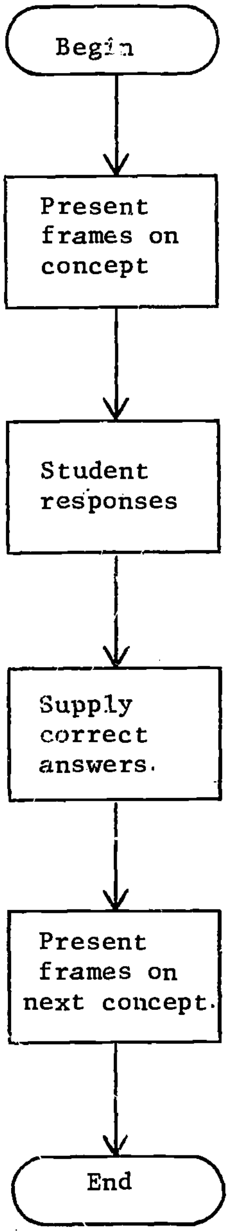

Begin
Present material.
Check to see if students are having difficulty
Many?
YES
NO
Test
Most passed?
NO
Time to go over again?
YES
YES
NO
Present new material
End

INSTRUCTIONAL STRATEGY - Example C

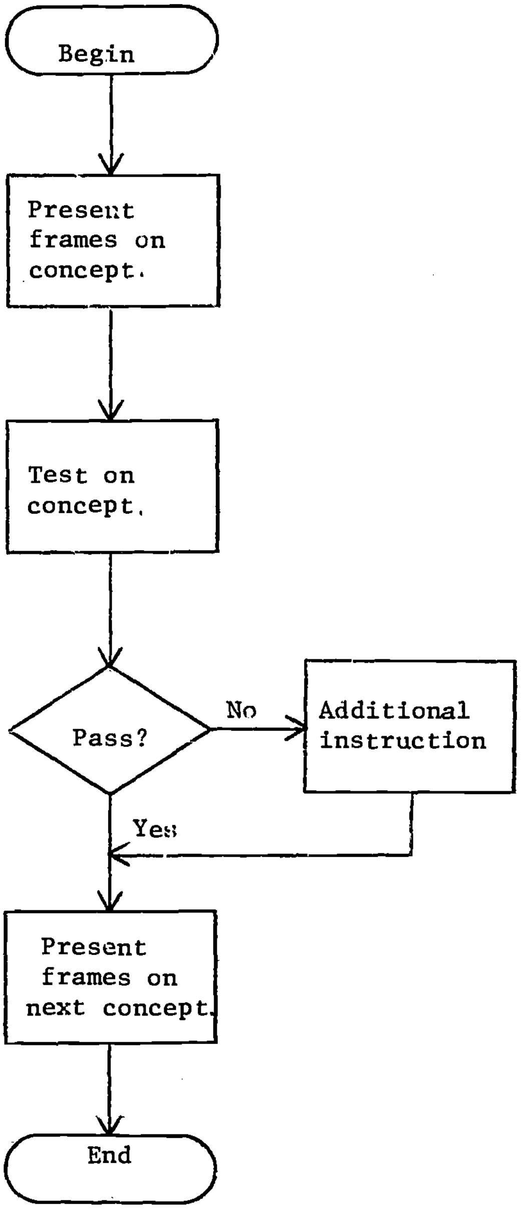

Strategy for Individualizing Instruction
Start
Diagnostic test
Each student presented material at his level
A
Test on a specific objective
Passed?
NO
YES
1st Time?
YES
NO
Try another method of instruction
A
Instruction presented for next objective
Stop

INSTRUCTIONAL STRATEGY - Example D

Linear Sequence


Begin
Present frames on concept
Student responses
Supply correct answers.
Present frames on next concept.
End

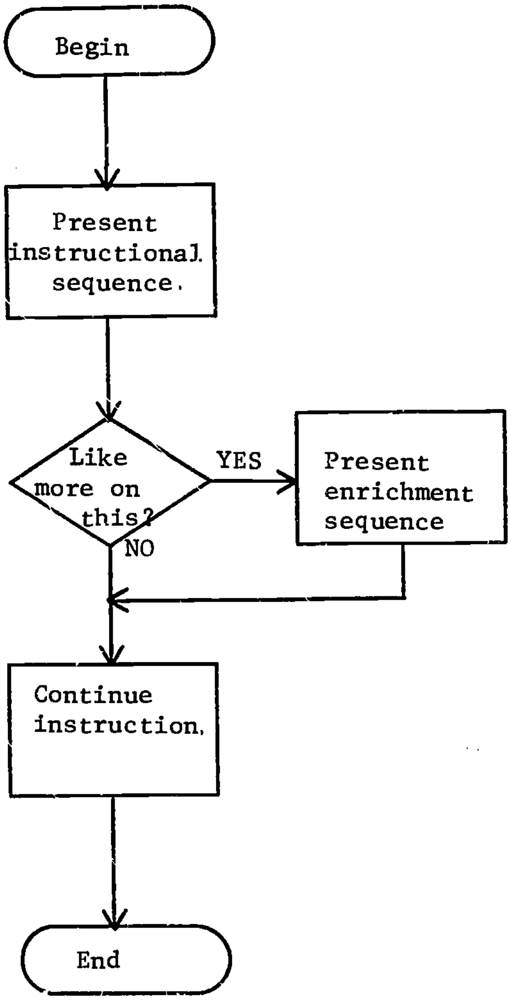
Modified Linear Sequence


Begin
Present frames on concept.
Test on concept.
Pass?
No
Additional instruction
Yes
Present frames on next concept.
End

INSTRUCTIONAL STRATEGY - Example E

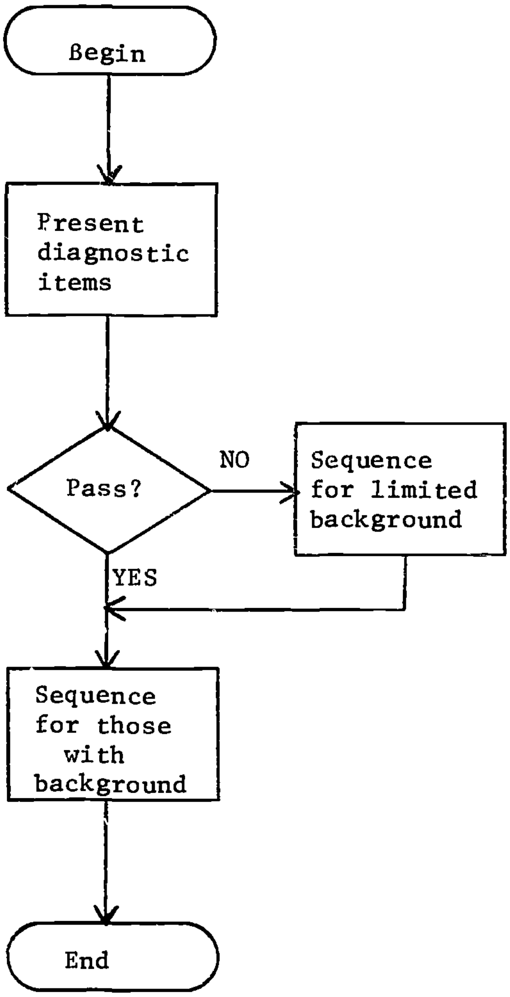
Linear Sequence

with Sub-linears


Begin
Present instructional sequence.
Like more on this?
YES
NO
Present enrichment sequence
Continue instruction.
End

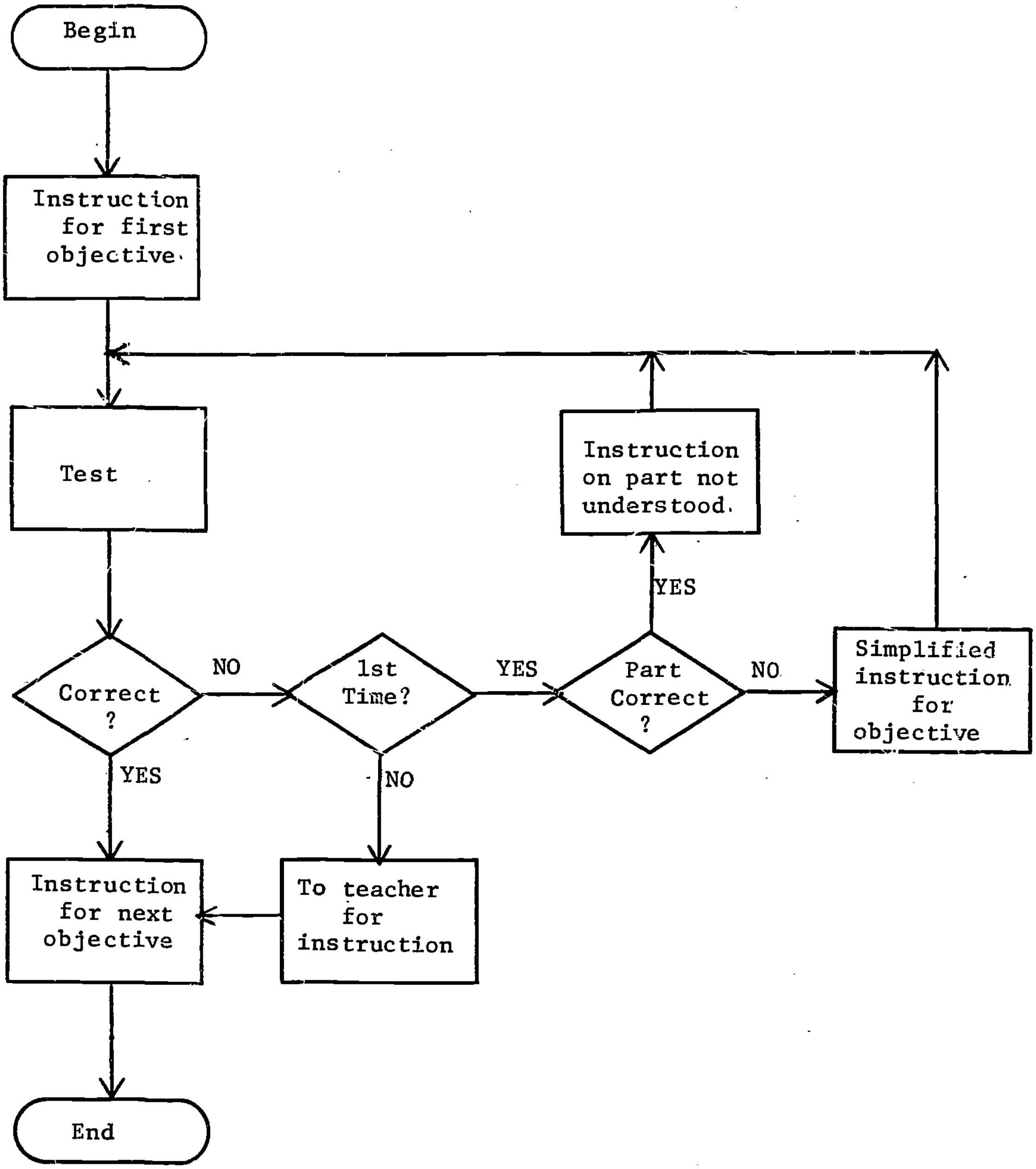
Linear Sequence with

Diagnostic Frames


Begin
Present diagnostic items
Pass?
NO
YES
Sequence for limited background
Sequence for those with background
End

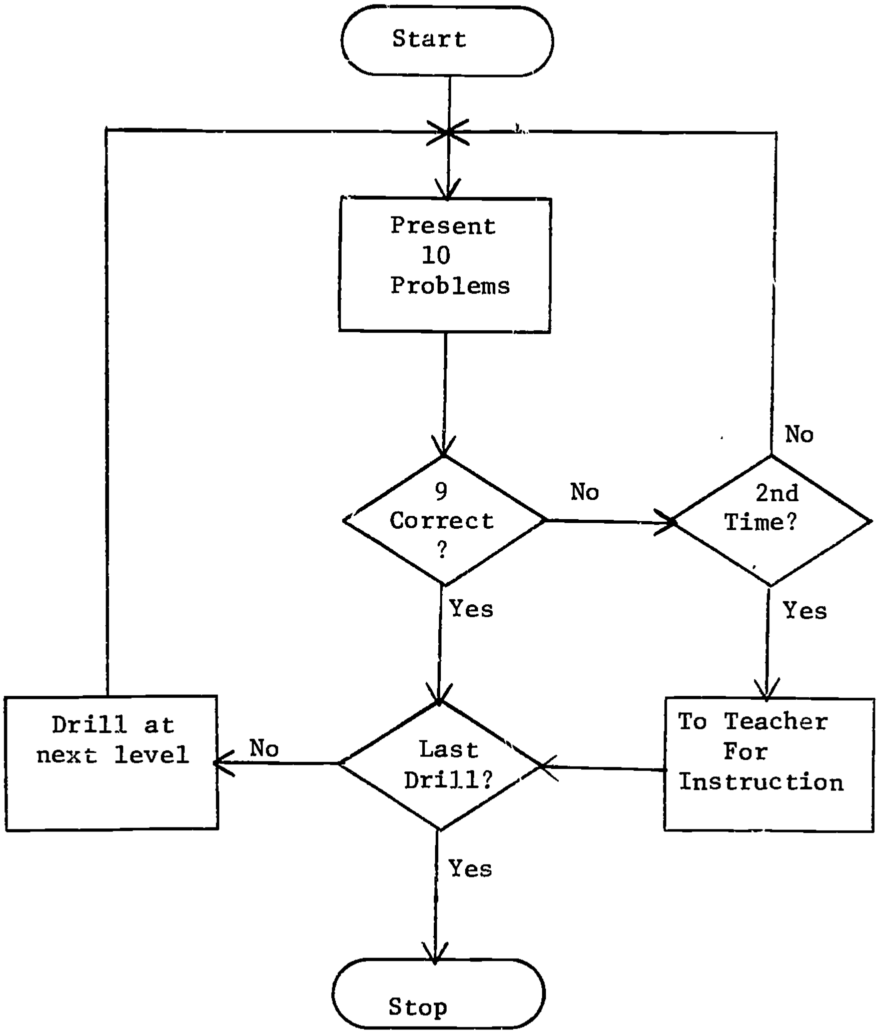
INSTRUCTIONAL STRATEGY - Example F

Simple Branching Sequence


Begin
Instruction for first objective.
Test
Correct ?
NO
1st Time?
YES
Part Correct ?
NO
Simplified instruction for objective
YES
Instruction on part not understood.
YES
NO
Instruction for next objective
To teacher for instruction
End

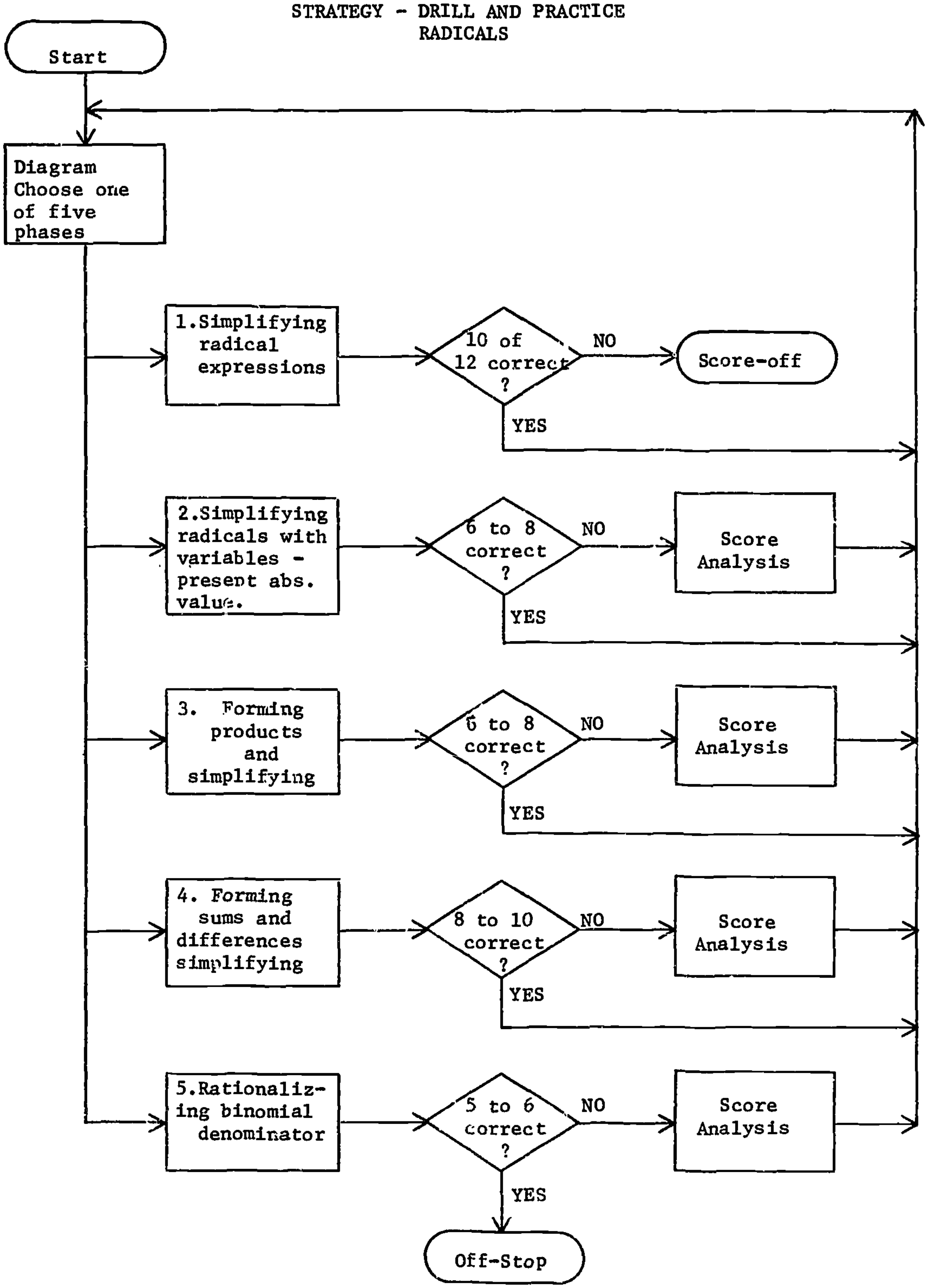
INSTRUCTIONAL STRATEGY - Example G

Strategy for Individual Drill Level



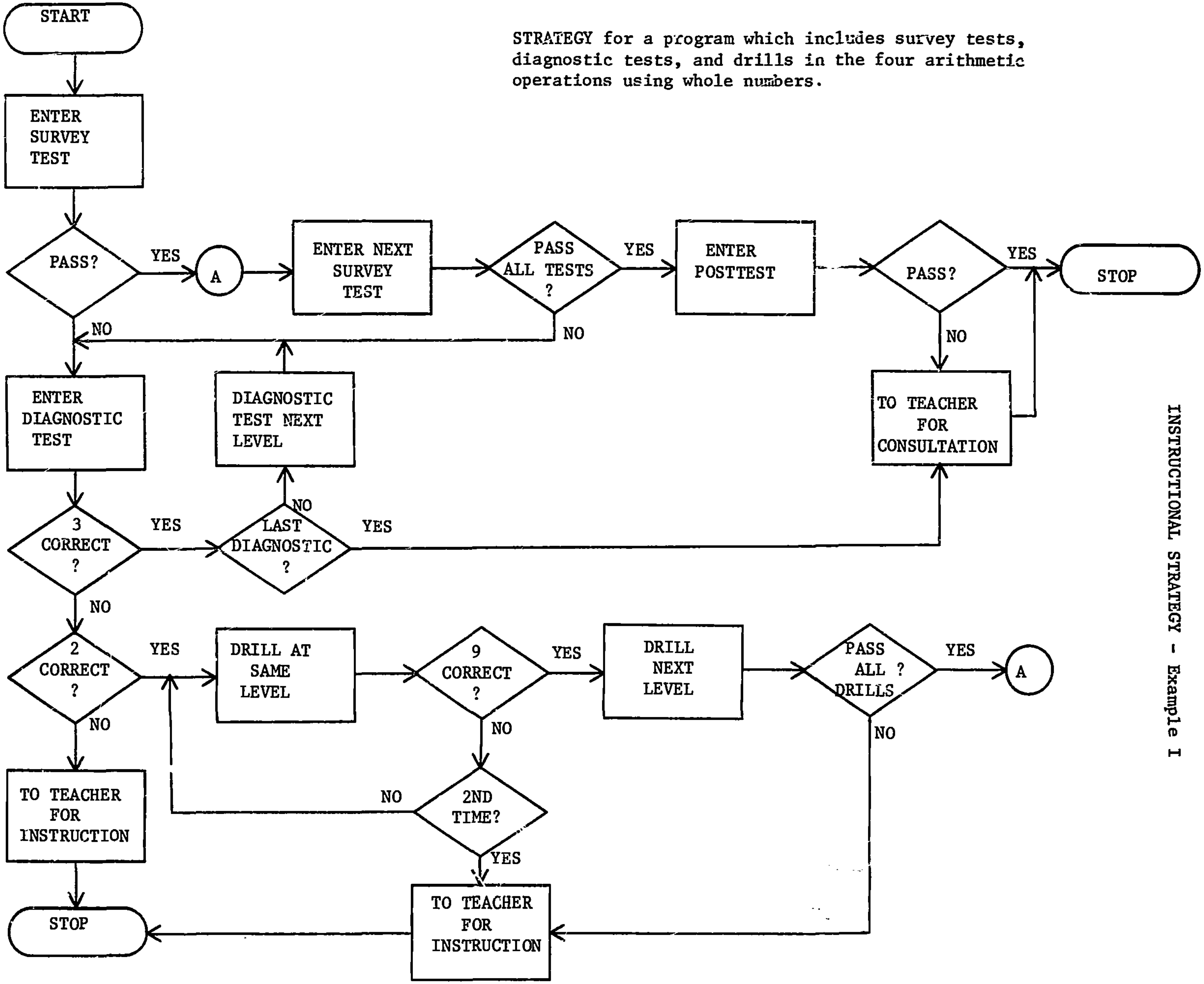
Start
Present 10 Problems
9 Correct ?
No
2nd Time?
No
Yes
Yes
Drill at next level
No
Last Drill?
To Teacher For Instruction
Yes
Stop

INSTRUCTIONAL STRATEGY - Example H


STRATEGY - DRILL AND PRACTICE
RADICALS
Start
Diagram Choose one of five phases
1.Simplifying radical expressions
10 of 12 correct ?
NO
Score-off
YES
2.Simplifying radicals with variables - present abs. value.
6 to 8 correct ?
NO
Score Analysis
YES
3. Forming products and simplifying
6 to 8 correct ?
NO
Score Analysis
YES
4. Forming sums and differences simplifying
8 to 10 correct ?
NO
Score Analysis
YES
5.Rationalizing binomial denominator
5 to 6 correct ?
NO
Score Analysis
YES
Off-Stop

INSTRUCTIONAL STRATEGY - Example I

STRATEGY for a program which includes survey tests, diagnostic tests, and drills in the four arithmetic operations using whole numbers.


START
ENTER SURVEY TEST
PASS?
YES
A
NO
ENTER NEXT SURVEY TEST
PASS ALL TESTS ?
YES
NO
ENTER POSTTEST
PASS?
YES
NO
STOP
TO TEACHER FOR CONSULTATION
ENTER DIAGNOSTIC TEST
DIAGNOSTIC TEST NEXT LEVEL
3 CORRECT ?
YES
NO
LAST DIAGNOSTIC ?
NO
YES
2 CORRECT ?
YES
NO
DRILL AT SAME LEVEL
9 CORRECT ?
YES
NO
DRILL NEXT LEVEL
PASS ALL ? DRILLS
YES
NO
A
2ND TIME?
NO
YES
TO TEACHER FOR INSTRUCTION
TO TEACHER FOR INSTRUCTION
STOP

C. MEDIA SELECTION

Medium or media are used to communicate the instructional message to the student. There is a variety of media from which the author of a learning module might choose--ranging from a simple paper and pencil activity at one end of the spectrum to a multisensory computer terminal at the other end. Ideally, the instructional technologist should select the medium which will produce the greatest amount of learning in the least possible time at the lowest possible cost. Unfortunately, no scientifically established rules presently exist for the selection and application of media to specific objectives. This being the case, the author must rely on his own experiences, knowledge, and common sense to guide his selection of a presentation medium for his module.

The author should begin by carefully examining his lesson hierarchy in order to identify the learning activities necessary for the attainment of the objectives. The next step is to determine what media are realistically available in terms of cost for hardware and/or time to develop materials. Of those media available, which ones are suitable for presenting the required learning activities to students of this age and ability level? Finally, compared with other available media, is the one being considered sufficiently more effective to be worth the difference in cost?

D. PROGRAMMED INSTRUCTION

Programmed instruction is a process for guiding a student toward the attainment of specific learning objectives through a series of carefully sequenced steps contained in a self-instructional package. These steps may be arranged in either a linear or a branching format. In a linear program, every student must follow the same path through the instruction. The branching format, on the other hand, allows the student to follow different paths based on his previous responses, thereby tailoring the program to his individual needs. In addition, programmed materials may employ various types of presentation media, ranging from a programmed text to a time-shared computer with multi-sensory student stations.

Regardless of the format or medium employed, all programmed materials have four characteristics in common. First, the materials to be learned are presented in small steps. Second, the student's attention is focused on each small segment of material by requiring him to actively respond before continuing to the next step. Third, immediately after the student makes a response, he receives feedback on the appropriateness of his answer. Finally, each student progresses through a program at his own rate.

OBJECTIVES

At the end of this learning experience, the participant will:

1. Name four principles of programmed learning.

2. Given a programmed instruction frame, identify the three parts.

3. Describe the three parts of a programmed instruction frame.

4. Given a programmed instruction frame which includes the presentation of information and the request for the student response, construct the part which supplies the answer and directs the student to the next part of the program.

5. Given a programmed instruction frame which includes the presentation of information and supplies the answer and the instructions to the student, construct the part which requires the student to respond.

6. Given the objective for a programmed instruction frame, including a brief description of its content, construct a frame which includes the three parts.

7. Describe the function of each of the following types of frames:

    a) Teaching frame
    b) Practice frame
    c) Criterion frame

8. Given a programmed sequence, identify the teaching, practice, and criterion frames.

9. Given the objective for a programmed sequence, the teaching frame(s), and the practice frames, construct the criterion frame(s) for the sequence.

10. Given the objective, the teaching frame, and the criterion frame for a programmed sequence, construct the practice frames.

11. Given the objective and a description of the content including specific examples, construct a programmed sequence with teaching, practice, and criterion frames.

12. Define cueing and fading.

13. Change the cueing and fading in a programmed sequence to satisfy Pipe's suggestions (Pipe, Practical Programming, pp. 41-47).

14. Define each of the following approaches for sequencing programmed items:

    a) Ruleg
    b) Egrul
    c) Mathetics

15. Given three examples of programmed instruction, one illustrating the ruleg approach, one egrul, and one mathetics, distinguish among them.

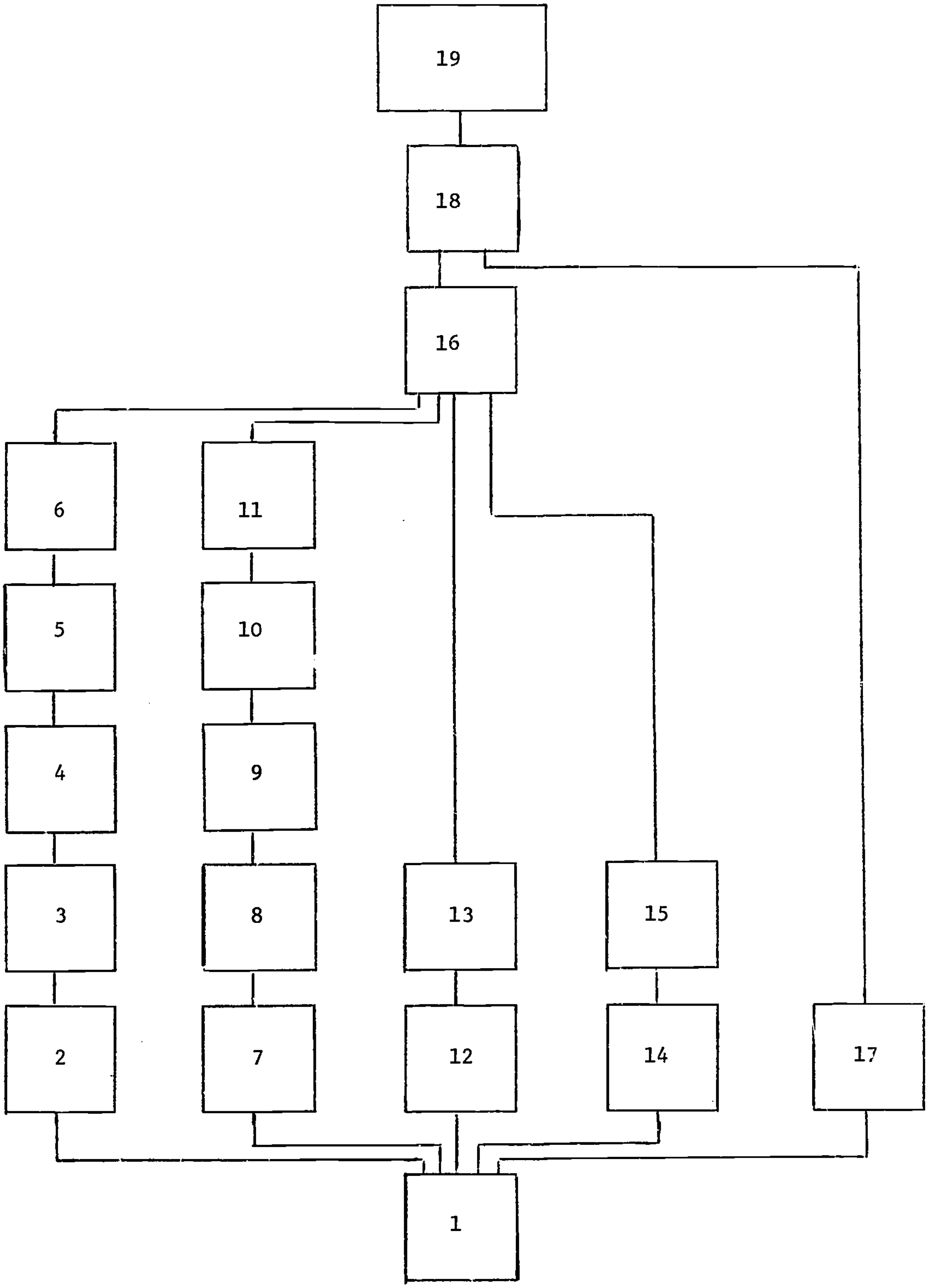
16. Given the objective and a description of the content, construct a brief linear sequence (six to ten frames) employing only one of the three approaches for organizing the sequence of frames. Include the three parts in each frame, and the techniques of cueing and fading.

17. State three differences between linear programs and branching programs.

18. Given the objective and a description of the content, construct a short branching sequence employing only one of the three approaches for organizing frame sequence. Include the three parts in each frame, the three types of frames, and the techniques of cueing and fading.

19. Select one of the objectives developed for an Individualized Learning Module and construct a programmed sequence which enables a student to acquire the behavior described by the objective.

PROGRAMMED INSTRUCTION - Hierarchy


19
18
16
6
11
5
10
4
9
3
8
13
15
2
7
12
14
17
1

PROGRAMMED INSTRUCTION - Suggested Procedures

I. Introduction

A. Distribute the topic description and objectives to the class.

B. Have participants read "Principles of Programmed Learning" and pages 1-17 in Practical Programming.

II. Instruction and Practice

A. Have each member of the class work through Activities 1-18 using several of the references listed in IV as necessary.

B. Check each activity as it is completed, it should be checked before the participant continues to the next.

III. Application

A. Have each participant perform the activity described in objective 19.

B. Once objective 19 has been completed and checked, have the participants develop the instructional sequence for their module.

IV. Bibliography

A. Calvin, Allen D. (ed.) Programmed Instruction. In Bold New Venture Series. Bloomington, Ind.: Indiana University Press, 1969. 250 pp.

B. Espich, James E. and Bill Williams. Developing Programmed Instructional Materials: A Handbook for Program Writers. Palo Alto, Calif.: Fearon Publishers, 1967. 138 pp.

C. Evans, James L. "Principles of Programmed Learning." Third edition. New York: Grolier, Incorporated, 1962. 13 pp.

D. Lysaught, Jerome P. and Clarence M. Williams. A Guide to Programmed Instruction. New York: John Wiley and Sons, Inc., 1963. 183 pp.

E. Markle, Susan Meyer. Good Frames and Bad: A Grammar of Frame Writing. New York: John Wiley & Sons, Inc., 1964. 278 pp.

F. Pipe, Peter. Practical Programming. New York: Holt, Rinehart and Winston, Inc., 1966. 70 pp.

PROGRAMMED INSTRUCTION - Activity 1

Name four principles of programmed instruction.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

PROGRAMMED INSTRUCTION - Activity 2

Using the frame illustrated below, circle each of the three parts of the frame and place the number 1, 2, or 3 within each circle. Then write the name of each part in the spaces provided. Be sure the number and description correspond.

---

37. The "father" of linear programmed instruction is generally agreed to be ________________________________.

- - - - - - - - - - - - - - - - - - - -

ANSWER: B. F. Skinner

Go to the next frame.

1.

2.

3.

PROGRAMMED INSTRUCTION - Activity 3

Describe the three parts of a frame.

1. ____

____

____

____

2. ____

____

____

____

3. ____

____

____

____

PROGRAMMED INSTRUCTION - Activity 4

Complete the following frame by constructing the part which supplies the answer and directs the student to the next part of the program.

---

5. The first requirement for an instructional objective is that it should be stated in terms of student performance. In other words, it should describe exactly what the student is expected to ______ ______________.

- -

PROGRAMMED INSTRUCTION - Activity 5

Complete the following frame by constructing the portion which requires the student to respond.

---

8. An instructional objective should describe what the learner will be doing when he is demonstrating his attainment of the objective. Which of the statements below is an instructional objective?

   A. The student will know the eight fundamental processes necessary to sustain life.

   B. The student will correctly match the names of the eight fundamental processes necessary to sustain life with the description of each.

- -

If you answered A, go to frame 15.

If you answered B, go to frame 10.

PROGRAMMED INSTRUCTION - Activity 6

Construct a programmed frame based on the following objective:

> Given the definition of a pentagon and the drawings of two or more polygons, including one of a pentagon, the student will identify the pentagon.

PROGRAMMED INSTRUCTION - Activity 7

Describe the function of the following types of frames:

Teaching frame - ____________________________________

____

____

Practice frame - ____________________________________

____

____

Criterion frame - ___________________________________

____

____

PROGRAMMED INSTRUCTION - Activity 8

Identify the teaching, practice, and criterion frames in the following programmed sequence by placing a T, P, or C by the number of the frame.

---

1. In order to square a number, multiply the number by itself. For example, to square 2, multiply 2x2. The answer is 4.

   To square 3, multiply 3x3. The answer is ____.

   ANSWER: 9

---

2. The square of 5 is: 5x5=25.

   The square of 6 is: 6x__=__.

   ANSWER: 6, 36

---

3. The square of 4 is 16. The square of 8 is ___.

   ANSWER: 64

---

4. The square of 9 is ____.

   ANSWER: 81

PROGRAMMED INSTRUCTION - Activity 9

The objective, the teaching frame, and the practice frames are provided below. Using this information construct the criterion frame at the end of the sequence.

Objective: At the end of this experience, the student will name the terms, "instructional objective" and "criterion test" when given the definitions: "describes the behavior or performance expected at the end of a learning experience" and "determines if a student has attained the behavior described in an instructional objective."

---

1. A CRITERION TEST is used to determine if a student can perform the behavior described in an INSTRUCTIONAL OBJECTIVE.

   A student's attainment of an instructional objective is determined by

   by a ________________________test.

- -

CRITERION

---

2. The criterion test determines whether a student can perform the behavior described

   in an instructional ____________________________.

- -

OBJECTIVE

---

3. It is possible to decide when a student has successfully completed a learning

   experience because the ____________________________ objective describes the student's

   expected ________________________.

- -

INSTRUCTIONAL

BEHAVIOR or PERFORMANCE

4. A criterion test can be used to determine the success of a learning experience because a student's expected performance is precisely defined in a(n) ____________ ______________________.

INSTRUCTIONAL OBJECTIVE

5. At the end of instruction, the behavior described in the instructional objective must be demonstrated on a ________________ test.

6\.

PROGRAMMED INSTRUCTION - Activity 10

The objective and the teaching and criterion frames for a short programmed sequences are provided below. Complete the sequence by constructing two or three practice frames in the spaces supplied.

Objective: Given a per cent in form of n % where n is an integer or a decimal numeral, the student will write the decimal equivalent.

---

1. n % means n x .01

Examples:

a) 45% = 45 x .01
45 x .01 = .45

b) 115 % = 115 x .01
115 x .01 = 1.15

c) 2.7% = 2.7 x .01
2.7 x .01 = ______?___

- -

.027

2.

- -

3.

- -

4.

- -

PROGRAMMED INSTRUCTION - Activity 10 (continued)

5. For each of the following, write the decimal equivalent:

   a) 13% =
   b) 201% =
   c) 3.9% =

- -

   a) .13
   b) 2.01
   c) .039

PROGRAMMED INSTRUCTION - Activity 11

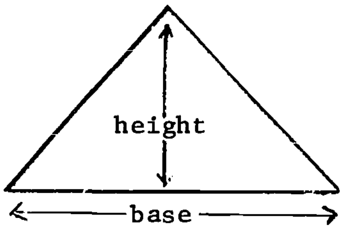
Using the objective and the information supplied below, construct a short programmed sequence.

OBJECTIVE

Given a drawing of a triangle with the base and height measurements indicated, the student will find the area of the triangle.

Use the following information within the instruction:

1. Formula for finding the area of a triangle - Area: $\frac{1}{2}$(base x height)
2. A drawing of a triangle



PROGRAMMED INSTRUCTION - Activity 12

Define the following terms:

Cueing - ____

Fading - ____

PROGRAMMED INSTRUCTION - Activity 13

After reading pages 41-47 in Peter Pipe's Practical Programming, change the cueing and fading in one of the programmed sequences constructed for Activities 10 and 11 to satisfy Pipe's suggestions.

PROGRAMMED INSTRUCTION - Activity 14

Define each of the following approaches for sequencing programmed items:

Ruleg - ____

____

____

____

Egrul - ____

____

____

____

Mathetics - ____

____

____

____

PROGRAMMED INSTRUCTION - Activity 15

Examine the three programmed segments illustrated in Example A, pages 118-119, Example B, page 120 and Activity 8 page 108. The approaches for sequencing programmed materials (ruleg, egrul, mathetics) are represented. Write the name of the approach illustrated by each example or activity in the spaces below.

Example A ____________________

Example B ____________________

Activity 8 ___________________

PROGRAMMED INSTRUCTION - Activity 15 (continued)

Example A

---

1. In words ending in e, as in hate, file, and change, the e is (sounded / silent).

/ SILENT

---

2. When a suffix is added to a word ending in a silent e, sometimes the e is dropped and other time it is retained. For example, when ing is added to change (changing), the e is ____________. But when less is added to change (changeless), the e is ________.

DROPPED

RETAINED

---

3. The suffix ing begins with a (consonant / vowel). When ing is added to hate (hating), the e is ___________.

/ VOWEL

DROPPED

---

4. When the suffix less is added to use (useless), the silent e is ___________. The suffix less begins with a (consonant / vowel).

RETAINED

CONSONANT /

---

5. There are two rules for adding suffixes to words that end with a ____________ e.

a. If the suffix begins with a consonant, the e is ______________.

b. If the suffix begins with a vowel, the e is __________________.

SILENT

RETAINED

DROPPED

PROGRAMMED INSTRUCTION - Activity 15

Example B

---

1. Divide 173 by 2.

80 2's have been taken out of 173.
That leaves 13.
6 more 2's can be taken out. 6 x 2 = 12.

To get the remainder, subtract 12 from 13.
Write the answer here.

$$\begin{array}{r} 86 \\ 2\overline{)173} \\ \underline{16} \\ 13 \\ \underline{-12} \\ \end{array}$$

Answer: 1

---

2. Divide 378 by 5.

60 5's have been taken out of 378. This leaves 28.
5 more 5's can be taken out, so write 5 here.

$$\begin{array}{r} 65 \\ 5\overline{)378} \\ \underline{35} \\ 28 \\ \underline{} \end{array}$$

Since 28 is left, take 5 more 5's out.
Write the product of 5 x 5 here.

Now find the remainder.

Answer: 5 x 5 = 25
Remainder is 3

---

3. Divide 263 by 3.

80 3's have already been taken out of 263. This leaves 23.

How many 3's can be taken from 21?
Write the number here.

$$\begin{array}{r} 8 \\ 3\overline{)263} \\ \underline{24} \\ 23 \\ \underline{} \end{array}$$

Write the product of that number times the divisor here.
Finish the problem.

Answer:

$$\begin{array}{r} 87 \\ 3\overline{)263} \\ \underline{24} \\ 23 \\ \longrightarrow \left\{ \begin{array}{r} \underline{21} \\ 2 \end{array} \right. \end{array}$$

PROGRAMMED INSTRUCTION - Activity 16

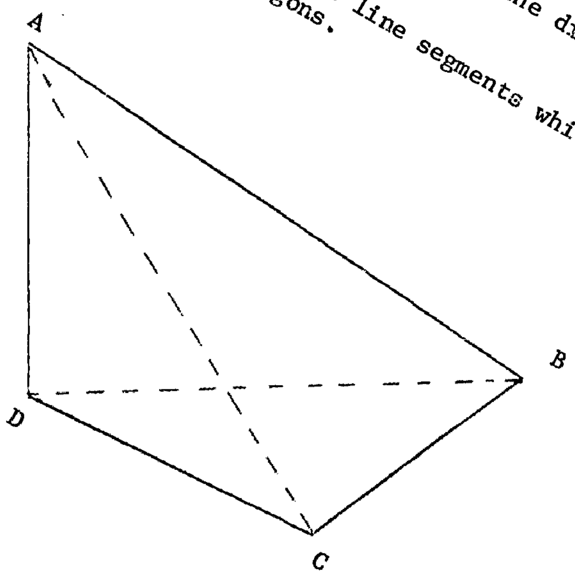
Using the objective and the description of the content provided below, construct a brief linear sequence (six to ten frames) employing only one of the three approaches for organizing the sequence of frames. Include the three parts of each frame, the three types of frames, and the techniques of cueing and fading.

OBJECTIVE

Given an incomplete definition of the diagonals of a polygon, the student will fill in the blanks correctly.

Diagonals of polygons are line segments which are drawn between vertices but which are not sides of the polygons.

Example:



$\overline{AC}$ and $\overline{BD}$ are diagonals of the polygon ABCD.

$\overline{AC}$ is read line segment AC.

PROGRAMMED INSTRUCTION - Activity 17

State the three differences between linear programs and branching programs:

1. ____

____

____

____

2. ____

____

____

____

3. ____

____

____

____

PROGRAMMED INSTRUCTION - Activity 18

Using the objective and the description of the content employed in Activity 16, construct a short branching sequence. Use only one of the three approaches for organizing the frame sequence. Include the three parts in each frame, the three types of frames, and the techniques of cueing and fading.

E. COMPUTER-ASSISTED INSTRUCTION*

Computer-assisted instruction, as defined in this course, is the utilization of remote time-shared computer terminals to assist the teacher in assuring student attainment of specific learning objectives through the individualization of the instructional process. Although the only medium receiving specific attention in this course, CAI is not a complete learning system but only one of many components within a multi-media individualized learning environment. CAI strategy seldom consists of a single technique but usually contains various combinations of the following techniques:
(1) Tutorial Dialogue, (2) Drill and Practice, (3) Simulation, (4) Problem Solving, and (5) Testing.

OBJECTIVE

Name and describe the five basic techniques of computer-assisted instruction.

1. Tutorial Dialogue

One of the most extensively developed CAI techniques is the tutorial dialogue between a student and the computer. This technique is characterized by (1) the presentation of learning material to the student in various step sizes, (2) a question or test item, and (3) evaluation of the student's response, reinforcement, and/or branching to another section of the instructional program. Essentially, there are two basic formats in which the tutorial technique is presently being used in CAI lesson design. The first consists of a "complete" tutorial dialogue between the student and the computer. This is to imply that all information, concepts, and learning materials are presented to students via the CAI terminal; and no "off-line" methods are used. Except in the lower elementary grades, this amounts to a tremendous quantity of material flowing through the computer; and, if exaggerated, the computer has a tendency to develop into an expensive page-turner.

The second type of tutorial lesson is referred to as a "partial" tutorial dialogue. The student's initial exposure to the material to be learned is from an off-line source, such as a traditional lecture, ETV, or reading material. The material may initially be presented to the student in a more rapid, condensed form, which is limited to one-way communication. The student would next be exposed to diagnostic testing routines via CAI, which would test his attainment of each concept presented via the initial source and branch him to two-way tutorial routines as previously described.

2. Drill and Practice

A second basic CAI techniques is the utilization of remote terminals for what otherwise might be long and tedious drill and practice exercises of concepts to which students have been previously exposed. To date, this technique has been most usefully exploited at the elementary school levels via remote teletype or typewriter terminals. The instructional strategies are usually quite simple, as the computer is used to provide practice in particular concepts, and diagnose the child's weaknesses. At the end of each day, the computer can indicate to the teacher which pupils need help, and their specific areas of difficulty.

---

* Adapted from William M. Richardson, "Implementation of Computer-Assisted Instruction in the Montgomery County, Maryland, Public Schools" (paper presented at the National Society of Programmed Instruction Symposium on Implementation of CAI, Washington, D. C., April 10, 1969).

There are basically two types of drill and practice exercises. The first consists of practice problems and routines that are designed by the course author, generated by the instructional program, and presented to the student via the computer terminal.

The second type of drill and practice exercise is substantially different as the student is allowed to generate his own problem set. Such an exercise provides the student with the opportunity to construct his own problem set and input data and to respond with his solution to the practice problem. The computer calculates the correct answer and compares it to the student's response. The instructional program may branch the student to particular additional problems or suggest the student construct a particular kind of problem or one of increased difficulty.

3. Simulation

Computer simulation of laboratory exercises and other real world situations represents a third significant CAI technique. In this situation a mathematical model is generated which simulates the real life occurrence of a particular environment and allows the student to interact with the model. This technique can provide learning experiences to students that might not otherwise be available because of factors such as safety, equipment cost or availability, prohibitive set-up time, or other factors of cost or convenience. The simulation of high school laboratory exercises can take different forms. There are a number of experiments which are desirable to perform in high school if sufficient equipment or time is available; these experiments may be simulated by the construction of mathematical models for exposure to all students or used as enrichment for more advanced students. Another utilization of simulated laboratory experiments is for practice of particular science concepts after a laboratory experiment has been performed. A simulation can also be a group classroom demonstration which is integrated into the traditional instructional setting.

4. Problem Solving

Problem solution involves the utilization of remote computer terminals to perform calculations of various complex formulas or expressions; this reduces the time students devote to routine calculations. The calculational power of the computer is brought into the classroom in an effort to introduce more complex learning materials.

There are two fundamental modes in which remote terminals can be utilized for problem solving. First, the instructor in a traditional classroom or laboratory situation can use the terminal to "demonstrate" the result of changing various parameters of a complex equation. In such a situation only the instructor or a small number of the students actually interacts with the terminal, but its results are used to support concepts presented in class.

The second mode of the problem solving technique consists of individual students utilizing the calculational power on a real-time basis in conjunction with CAI materials. For example, if at a particular point in the design of a CAI lesson it would be advantageous to have the student solve a complex mathematical expression, he can do so without leaving the instructional setting.

5. Testing

The fifth basic CAI technique is testing. This technique can be applied either as a stand-alone application or, as most frequently occurs, in combination with one of the other basic techniques. CAI materials should exploit fully the computer's ability to present criteria tests, collect student responses, and analyze large volumes of data. There are numerous methods of applying the testing technique to CAI instructional strategies. Measures of student attainment of specific objectives, diagnostic testing for remedial sequences, curriculum validation criteria, and administrative testing are some applications of the testing technique.

F. COMPUTER FUNDAMENTALS AND LANGUAGES

An accurate, high speed electronic device which stores information magnetically, and retrieves it on command and processes data according to programmed instructions is called a computer. Although more complex than most other mechanical and electronic equipment available for instruction today, it is only a machine. The computer medium, just as any other, is only as good as the material it communicates. One does not need to have an extensive knowledge of computers to write good programs. A CAI author does, however, need a basic understanding of computer operation, capabilities, and limitations in order to create programs which will utilize the unique characteristics of the computer.

A computer program contains a series of instructions, one for each individual operation the computer performs. Sets of these instructions, written in special codes, are called languages.

When the first electronic computers were developed in the early 1940's, it was necessary to write all computer instructions by using machine language employing the binary number system and assigning each bit of information to a location in storage. Not only was this time consuming, but mistakes were numerous. Besides only a very few highly skilled people could accomplish this type of programming.

The discovery that the computer itself could be used to convert alphabetic codes into machine language opened the way for large-scale computer use. Mathematical and scientific languages were developed first, followed by those for business applications. Recently, several languages have been developed specifically for computer-assisted instruction, such as INFORM, PLANIT, DIALOG, and Coursewriter I, II, and III.

OBJECTIVES

At the end of this learning experience, the participant will have a basic knowledge of computer fundamentals. He will:

1. List the three types of operations a computer can perform.
2. Name the five basic components of a computer system, describing their functions and the relationships among them.
3. Distinguish between the computer concepts of batch processing and time sharing.
4. Define the terms "hardware" and "software" as they relate to computer systems.
5. Name and order the five fundamental steps in the development of a computer program.
6. Name and describe the seven basic computer storage devices.
7. State the characteristic that differentiates sequential and direct access storage devices.
8. Name and describe the four basic types of remote terminal devices.
9. Describe the function of a computer language.

COMPUTER FUNDAMENTALS AND LANGUAGES - Suggested Procedures

I. Introduction*

A. Distribute copies of the topic description and objectives as well as pages 124-126.

B. Discuss the present and projected uses of computers in education.

C. Emphasize the value of having a basic knowledge of the computer's capabilities and limitations as an instructional medium.

II. Instruction

A. Have the class read Computing Systems Fundamentals: Test--Unit I and "Programming: Words That Move Machines."

B. Discuss the reading and topic objectives and answer any questions. (Specific information on two CAI languages, Coursewriter II and APL, is included in Appendices C and D.)

C. Visit an operational CAI installation, if possible.

III. Practice--Quiz on the topic objectives.

IV. Bibliography

A. Computing Systems Fundamentals: Text--Unit I. Form R29-0241-3. International Business Machines Corporation, 1967.

B. Gielow, Fred C., Jr. "Introducing . . . the Computer." Form 520-1541-0. New York: International Business Machines Corporation.

C. "Programming: Words That Move Machines." Form 520-1498-0. New York: International Business Machines Corporation.

D. "You and the Computer: A Student's Guide." New York: General Electric Company, 1965.

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*The procedures employed to develop CAI materials for Project REFLECT are detailed in the Curriculum Development Subplan located in Appendix A.

G. EDITING AND PILOT TESTING

Careful editing of the Individualized Learning Module before translating it from the paper draft to the presentation medium will save time and money. Editing a lesson segment involves three steps. First, the content is examined for accuracy. Any incorrect or misleading statements are amended, and any important information which may have been omitted is inserted. Next, the composition is checked for grammar, language, spelling, ability to communicate, etc. Finally, the module is inspected to insure that it flows smoothly, logically, and according to the instructional strategy.

Once the author is satisfied with the edited module, he should ask several colleagues to review it and, based on their suggestions and comments, make any desirable changes. In some cases, the module cannot be effectively tested unless it has been translated to the presentation medium. In this situation, another edit will be required before the pilot test.

Pilot testing is one of the most important steps in the development of an Individualized Learning Module. The only way the author can develop materials which effectively teach is try out his materials with students from the target population. Based on the resulting feedback, the author must revise the module until it enables students to perform successfully the lesson objectives. A basic principle of instructional technology is that whenever a student, who has the prerequisite behaviors for entering a lesson segment, does not attain the terminal objectives, the author has failed and not the student.

The students who are selected to test the module should have average ability for the target population. After choosing the test subjects, the author records any background information about each student which may affect the tryout results, such as age, sex, grade level, course background, interests, reading level, or relevant achievement scores. Before the tryout begins, the students should be informed that they are not being tested, but rather the module is. Emphasizing the important contribution they are making toward development of the module generally insures a serious and cooperative approach to the tryout on the part of the students.

Normally, pilot testing is a two-phase process involving six to eight students. In order to discover any major flaws in the module and to determine whether it communicates with the user, the author first tests the lesson with two or three students on a one-to-one basis. During this phase the author carefully notes the student's reactions and responses to individual items within the lesson. He also discusses with the student any areas of difficulty and records the student's comments and suggestions. Based on each student's performance, comments, and suggestions, as well as his own observations, the author makes the first major revision of the module.

Small-group tryout is the second phase of pilot testing. This time approximately five students work through the instructional sequence without help or instruction from the author. When the students find areas where the material is difficult or where instructions are unclear, they record their comments in the manner prescribed by the author. The data accumulated from this tryout supply the information necessary for the last major revision before field testing the module.

In both phases of pilot testing, the segment should be presented in the form in which it will be used for instruction. This includes administering entering behaviors tests, pretests, diagnostic tests (if desired), and posttests. In addition to these test scores, the author will want to record the amount of time each student takes to complete the lesson and any observable student reactions during the tryout. Also, provision should be made to collect student comments and suggestions as they work through the module. This information will help the author determine whether his hierarchy and/or test items are valid and whether his instructional sequence is effective.

For a more detailed discussion of this topic, see pages 99-125 in Developing Programmed Instructional Materials by James E. Espich and Bill Williams listed in the bibliography.

PART IV

ANALYSIS AND ASSESSMENT OF EFFECTIVENESS

Validation, field testing, and evaluation provide the data for making decisions relating to the use of the module. The purpose of validation is to determine to what extent the learning module does what it was designed to do. If the package accomplishes its purpose (to the standards specified) with a group of sufficient number, the module is deemed valid for a population similar to the one tested and under the same conditions. After validation occurs, field testing is conducted to assess the effectiveness of the packet on a more extensive basis. Research procedures employing the validated materials can include comparative evaluations in which the results of module use are compared with results of instructional strategies employing other practices, procedures, or materials. Field testing and comparative evaluation may occur simultaneously. The interpretation of results and documentation of the research complete evaluation.

A. VALIDATION

Large-group testing with members of the target population using the module under the conditions for which it was designed begins the validation process. A pretest, consisting of criterion items on the terminal objectives, provides information which is used to separate those already possessing the behaviors from those not attaining the objectives of the module. Only persons lacking the terminal objectives but possessing the entering behaviors specified for the module may be included in the validation group. Use of the module occurs. Data collection, individual and group, at this stage includes complete performance information on terminal objectives, enabling objectives, and instructional items.

Data from the large-group tryout determines the next step. Validation is the process which determines whether or not a module does what it was designed to do. Performance data of those persons not possessing the terminal behaviors prior to use of the module is analyzed carefully. Validation is based on the percentage of students attaining the terminal objectives as a result of use of the module. If the performance of the group meets at least the minimum acceptable standards set for validation, the module is valid for that particular population under the conditions of the test. For instance, the acceptable standard could be 100 per cent of the students attaining 100 per cent of the terminal objectives. The data collected in the large-scale testing phase of validation is also employed in the validation of the hierarchy.

Performance data which indicates a packet is grossly inferior necessitates discard of the module, a rare occurrence. If a module fails to meet the set criteria, it is usually revised and tested with other large groups of the target population until at least the minimum acceptable standards for validation are achieved.

Documentation of the validation includes at least the number of persons tested and a description of the target population, the minimum acceptable standard for validation and the percentage of attainment, the method used to validate the hierarchy and the results of that validation, and the mean time for the module.

After validation has been completed, field testing and/or evaluation can occur.

B. FIELD TESTING

Use of the validated package with populations similar to the large group tested in the validation process but located in different environments is field testing. This use ascertains whether the module under varying conditions of environment actually elicits the behavioral changes it was designed to produce.

Field testing determines the effectiveness of the modular instructional package when less protected by the designer and identifies unexpected cultural or social factors which may influence use. Data obtained from the field test use may permit generalizations regarding the use of the module for a particular target population.

Since the module will be administered in this phase by many persons of differing backgrounds, a manual with directions, conditions, and other helps for the instructor is to accompany the program documentation. Data from the validation testing(s) is an important portion of the support information.

After the test sites have been selected and arrangements made for their use, staff orientation and training may occur. Then the field testing takes place. The documentation of this phase includes the performance data and the evaluation of the modular instructional package on the basis of the field test data. Limitations and restrictions discovered during the field test(s) should be clearly identified.

C. EVALUATION

If comparative studies which pit the results of modular instructional package use against results of other practices, procedures, or materials are based on sound research procedures, they can provide data which may be employed to make decisions regarding the module's implementation. While there are many types of evaluation, only studies of the just mentioned type are referred to here.

This section outlines a procedure for designing and conducting a comparative study. For supportive information, texts on statistics and educational research should be consulted.*

Adequate statement of the research problem is one of the most important parts of research. Although there is no one correct way to state a research problem, certain characteristics need to be incorporated. The problem should express a relation between two or more variables and be stated clearly and unambiguously in question form. The problem statement should imply possibilities for testing by experimental means. The variables used in the problem statement need to be amenable to testing.

*Celeste McCollough and Loche Van Atta. Statistical Concepts, A Program for Self-Instruction (New York: McGraw-Hill Book Company, Inc., 1963) 367 pp.

*Fred P. Barnes. Research for the Practitioner in Education (Washington: National Education Association, 1964) 141 pp.

Once a question is asked, hypotheses determine the approach to design. An hypothesis is simply a statement about relationships among variables. A specific statement of an hypothesis should be expressed. Again, care needs to be taken to ensure that this statement is clear and lacks amibguity.

The role of the researcher in the behavioral sciences is traditionally that of a skeptic. If an hypothesis is stated in terms of expected differences between two groups, a statistical test is carried out that assumes they are the same. The denial statement, the hypothesis of no difference, is know as the null hypothesis. The null hypothesis is NOT the stated hypothesis of interest to the researcher, but disproof of the null hypothesis gives credibility to the stated hypothesis.

At this point the research design is selected or structured. Such a design should identify how observations are to be made and analyzed to test adequately the hypotheses. Conditions of control need to be established for all variables other than those involved in the hypothesis. Ideally, the entire population would be used, but most researchers are forced to select some part as representative of the whole. If at all possible, sampling should be random, with selected subjects then randomly assigned to the treatment groups.

Use of the module, with data collection which employs the techniques identified in the research design, occurs. An error estimate, based on the randomization process, is the basis for the generation of an error estimate by which the significance of other data is judged. Appropriate statistical tests are applied, and the results are interpreted.

Following completion of each individual study, a report should be compiled which includes the history of the modular instructional package including validation data (and field test data, if available); the context in which it was used; a description of the study, including objectives, methods, data obtained, results of the study, and conclusions based on the evaluation.

APPENDIX A

CURRICULUM DEVELOPMENT SUBPLAN

MONTGOMERY COUNTY PUBLIC SCHOOLS

Rockville, Maryland

COMPUTER-ASSISTED INSTRUCTION
DEMONSTRATION PROJECT

CURRICULUM DEVELOPMENT SUBPLAN

August 20, 1969

Prepared by:
Catherine E. Morgan
Teacher Specialist in Curriculum

Approved by:
William M. Richardson
Director
CAI Demonstration Project

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I. Introduction

The Montgomery County Computer-Assisted Instruction Demonstration Project is designed to assess the role of CAI in an operational school setting and to demonstrate the feasibility of staff involvement at all levels in the use of CAI as an instructional medium. The project proposal specifies that modular instructional CAI packages will be developed, and available CAI materials written elsewhere will be adapted for use in MCPS. As a variety of media is being used and tested in the instructional program in the county school system at the present time, investigation will be made to see which aspects of the program may be presented to students more efficiently and more effectively by the use of the computer.

The master plan defines the areas of primary and secondary curricular efforts as:

Primary Efforts	Secondary Efforts
Elementary Arithmetic	Electronic Data Processing
Junior High Science	French
Mathematics	Social Studies
Senior High Science (Chemistry and Physics)	Elementary English and Reading Drill

These areas are extremely broad, which will allow for the use of the currently known CAI techniques such as (1) tutorial dialogue, (2) testing, (3) drill and practice, (4) remote computing, and (5) simulation; and, hopefully, the project may develop and test some new techniques.

As well as a variety of subject areas, the project has an instructional system by which auditory, visual, and tactual responses can be activated. The student terminal components will be varied, and the stations will contain combinations of the following units: cathode ray tube with keyboard, light pen, image projector, head set, and typewriter.

II. Background Information

A. Project Purposes

The objectives of the project are clearly delineated in the project proposal and have been restated in more explicit, measurable terms in the master plan. As this subplan is concerned with curriculum, the objectives directly related to curriculum will be discussed herein. Specifically, the plans for reaching the following objectives will be detailed:

1. The development of an evaluation document which will be the vehicle of review, evaluation, and use of existing CAI materials that are available and adaptable to public school use on the IBM instructional system. (III)
2. The development of a document which will relate the determination and definition of the application of CAI, utilizing an IBM 1500 Instructional System in the school classroom setting, and project this application to determine and define the application of CAI without particular hardware limitations in the school classroom setting. This activity would evaluate the various CAI instructional techniques, relate the use of the computer to other instructional media, and determine the use of the computer for other activities. (IV)
3. The production of "modular instructional packages" for use on the IBM 1500 CAI system. (IV)
4. The design and development of a program to determine the feasibility of using the IBM 1500 CAI system for testing and test development. (IV)

In conjunction with the above, the major emphasis in the development of curriculum will be on the invention of creative techniques of instruction and on innovative methods as to their use.

B. Project Philosophy

The philosophy of the staff concerning individualization of instruction for students is inherent in all aspects of the curriculum development plans. Testing entering behaviors, which are considered essential to acquiring new behaviors, will help prevent subsequent student failure. Pretests on materials to be presented preclude the possibility that a student will be subjected to instruction on knowledge and skills already learned. Diagnostic tests may be used to place a student, who has some knowledge, in the correct starting place. In the development of the strategy to be used for any unit, the student will be able to progress at his own rate and may also be able to choose his path.

Further concern about individualization will be displayed in the use of the instructional packet in the school program. Experiences with students in classroom and laboratory situations will prescribe methods of implementation of CAI modules in a school setting.

The plan will also delineate the roles of the project staff, involved school personnel, and other individuals in the development, implementation, and evaluation of CAI curricular materials.

C. Curriculum Design - Montgomery County

For curriculum design in Montgomery County, refer to Curriculum Design, Institutional Level, Bulletin No. 215, 1968, a MCPS publication.

D. Assumptions and Biases

The project staff believes that CAI has a place in the instructional process. However, in its investigation of techniques to be used for the development of materials, the staff feels that simulation may be an extremely effective use of CAI; and linear programmed instruction may be one of the least effective ways to use CAI.

With the above considerations in mind, this curriculum development subplan will define and describe the methods for choice, development, adaptation, and implementation of the modular instructional packages.

III. Development of Instructional Modules

This section of the subplan will describe methods for the choice and development of modular units of CAI curriculum. Further, it will discuss the plans for the inclusion of the module in the instructional environment.

A. Guidelines for Choice of Module

Guidelines for the selection of specific units of course content within the curriculum will be developed. At the present time, decisions reflecting the opinions of the director and the involved teacher specialist will be made, using the following criteria:

1. Module will lend itself to using CAI techniques.
2. Materials will be developed which may require a variety of approaches for individual student needs such as differences in:
    a) Vocabulary levels
    b) Modes of learning
    c) Rates of learning
    d) Degrees of challenge
    e) Interests
    f) Entering behaviors
3. Consideration will be given to developing some units for which
    a) Detailed item analysis will be useful to the teacher
    b) Diagnostic tests can be written
    c) Drill and practice exercises can be developed

B. Guidelines for Development of Lesson Segments

1. Assessment of need will occur.
2. Terminal objective(s) will be written.
3. Minimum entering measurable behaviors will be written with criteria test item(s) for each.
4. Enabling objectives will be written.
5. The objectives from 2 and 4 above will be arranged into a hierarchy presumed to be valid.
6. Criterion test item(s) will be written for each enabling objective.
7. A pretest and post-test for the module will be prepared.
8. A flowchart for the instructional strategy to be used will be prepared, which will include:
    a) CAI technique(s) to be used
    b) Level of achievement acceptable for continuance in program after criterion item(s)
    c) Branches for remediation or review
    d) Number of drill and/or practice exercises
    e) Time allowances for response
9. A list of computer components, additional equipment, and materials to be used will be prepared by:
    a) Deciding on the stimuli to activate student response--visual (CRT and image projector, TV, film), auditory (tape recorder, earphones), and tactile (manipulatory equipment to be provided at the terminal)
    b) Deciding on any additional printed material the student should have in conjunction with the student terminal
    c) Deciding on kinds of data on student performance to be accumulated for later analysis, together with a simplified daily printout for the classroom teacher

10. The segment will be written.
11. Instructional materials will be prepared, and arrangements for their production will be made with the teacher specialist in instructional materials.
12. The segment will be coded.
13. The segment will be functionally debugged so that there are no errors in logic and the course "flows" as intended by author.
14. The segment will be reviewed by the author. At this time any errors in grammar, spelling, and subject material will be corrected.
15. The segment will be tested with a small number of students. Student reactions will be collected.
16. The segment will be revised, where necessary.
17. The segment will be used with larger numbers of students for validation and evaluation.

C. Implementation of Modules in School Program

Several ways of implementing the CAI modules in the school program will be used and evaluated. Among the physical situations in the different schools will be the following:

1. One or two learning centers in the elementary school which
    a) May utilize CAI as a learning and computing tool
    b) May utilize CAI for diagnostic testing and drill and practice exercises
2. A typewriter terminal in the physics classroom
3. Four CRTs with light pen in the senior high mathematics laboratory
4. Four terminals in a central location in the senior high so that a variety of subject materials can be presented to students (Students from Newport Junior High School will use terminals in Albert Einstein High School.)

Each of the above physical setups will entail a different type of teacher involvement with the CAI materials to be used. Ideally, the teacher will direct his students to the computer for instruction, laboratory experience, drill and practice, exercises, or testing as needs arise. In the physics classroom and the mathematics laboratory, students will be able to write their own programs and will utilize the calculating capabilities of the computer. In some situations, students may be directed to the computer for enrichment units or initial introduction to a highly individualized section of a required segment in a subject.

During Phase II of the project, various plans for implementation of the CAI modules will be investigated and documented. The results of this investigation and documentation will be the basis for writing this section in the revisions of the Curriculum Development Sub-Plan.

D. Evaluation of Module

Course authors will be continually evaluating their materials after use by groups of students and after revision. (See Validation and Evaluation Subplans.)

E. Survey and Study of CAI Materials Generated by Other Institutions

1. Procurement of CAI Materials

The director of the project will make initial contact with other institutions to procure CAI materials. Using the guidelines for selection listed below, the director in conjunction with the teacher specialist in the subject area involved will make decisions about materials to be acquired for perusal.

2. Criteria for Selection

The following aspects of procurement and adaptation of available CAI materials will be explored:

a) Cost

b) Constraints on use

   (1) Copyrights exist on the materials

   (2) The use of the materials is dependent upon the requirement that no changes be made

c) Suitability

   (1) The materials are appropriate for use within the present MCPS curriculum

   (2) The materials are appropriate for trial within a course(s) in MCPS curriculum, but material is not presently taught.

   (3) The materials represent the contents for a course not presently taught in MCPS.

d) Adaptablity

   (1) Changes will need to be made in instructional strategies because of differences in hardware and computer language.

   (2) Changes will need to be made in the materials so that they will be more useable for MCPS students.

   (3) Consideration will be made as to the time required for adaptation by:

      (a) Curriculum specialist and members of his design team

      (b) Technical staff

   (4) Cost of the above adaptations will be determined.

3. Adaptation Procedures

The teacher specialist and his design team will review the CAI materials procured and will specify plans for their use. Adaptation procedures will very closely follow the development procedures for original CAI packets as outlined in Section III of this subplan. (Form A)

4. Evaluation

Plans for evaluating the effectiveness of the materials will be the same as outlined in Section D.

F. Roles in Curriculum Development

1. Project Staff

a) Director. The director as the administrative offficer will:

(1) Liaison with the central office on the initiation of new curriculum efforts and changes in emphasis which will alter project objectives

(2) Advise the staff on the availability of the other CAI materials and will initiate the procurement of the same

(3) Confer at regular intervals with the teacher specialists regarding selection of instructional units and status of development of curriculum efforts in each subject area (See IV, Management.)

(4) Make decisions about publications and dissemination of project-produced materials

b) Administrative Assistant. The administrative assistant will:

(1) Assume duties of the director in his absence

(2) Coordinate curriculum production between the course authors and the technical staff

c) Teacher Specialists. The teacher specialists will each serve as a design team leader in the designated subject area.

(1) Teacher specialist in curriculum, high school science, will:

(a) Serve as the administrative assistant

(b) Be the design team leader for senior high school science

- (c) Review and adapt other CAI materials as delineated in Section IV of this sub-plan
- (d) Initiate and develop instructional modules as described in Section III of this subplan

(2) Teacher specialist in curriculum, mathematics, will:

- (a) Be responsible for the generation of the Curriculum Development Subplan
- (b) Be the design team leader for mathematics
- (c) Same as 3 a (3) above
- (d) Same as 3 a (4) above

(3) Teacher specialist in instructional materials will:

- (a) Be the design team leader in junior high school science
- (b) Be the instructional materials specialist and will:
  - i) Liaison with the Department of Educational Media and Technology
  - ii) Coordinate with course authors and technical personnel the visual and audio aspects of the modular instructional packages
- (c) Liaison with the project and the Department of Research
- (d) Same as 3 a (3) above
- (e) Same as 3 a (4) above

(4) Teacher specialist in staff development will:

- (a) Be the design team leader for social studies
- (b) Be the design team leader for French
- (c) Same as 3 a (3) above
- (d) Same as 3 a (4) above

(5) Teacher specialist in pupil and program appraisal will:

   (a) Be the design team leader in elementary school subjects

   (b) Liaison between the project and the Department of Pupil and Program Appraisal

   (c) Same as 3 a (3) above

   (d) Same as 3 a (4) above

d) Systems Manager. The systems manager will supervise the technical staff in the production of computer packages of curriculum.

e) Student Assistant-Graphic Arts. A student assistant will produce visuals as specified by course authors for modular instructional packages.

f) Senior Programmer. The senior programmer will develop assembly level computer programs for collection of student responses and response analyses.

g) Programmers. Programmers will code the course segments into a computer languages, Coursewriter II, or APL.

2. Design Teams

Design teams have been formed in senior high school science, junior high school science, mathematics, social studies, French, and elementary school subjects. Each of these design teams will function under the guidance of a teacher specialist on the project staff. Other design team members are teachers who work with the project 10 per cent of their time.

3. Involved Schools Personnel

Personnel from the involved schools will plan with the project staff for the implementation of CAI materials in the total instructional program.

Further, they may confer with the design teams in the choice and development of course materials.

4. Others

Nonproject individuals who are interested in developing a CAI segment will have the opportunity after January, 1970. The project is preparing an orientation manual which will contain a self instructional program presenting those concepts from educational technology which are essential for authoring a CAI segment. This manual will contain a compilation of the materials used in the project's development training courses. Persons who wish to be involved as authors of material should contact the project. Information of a general nature will be provided, and an interview will be arranged. If their interest is sustained, they will be given a copy of the manual mentioned above and a form on which to write detailed plans for developing a segment. After the form has been returned, the director will make the final decision about the value of the segment to the project.

IV. Management Control

Essential to good communication in an organization with diversified CAI production is the employment of management controls. The director and the staff should be informed about the status of curriculum development in the different areas at all times. To this end, the following techniques and forms will be used, testing them for efficiency in operations:

A. Curriculum Development Projection

Design team leaders will make projections for their areas of curriculum. A PERT chart or a report will be prepared with projected dates for starting, authoring, and completing each segment. The chart or report will be updated periodically and extended for one year, the first six months to be in detail.

B. Curriculum Development Review

The director will review curriculum materials under development with design team leader on a regular schedule each month.

C. Curriculum Development Sequencing

1. MIP Cover Sheet. Authors will attach a cover sheet to each instructional segment which is ready for coding and give the package to the administrative assistant who will forward it to the system manager. As each phase of programming is completed, the cover sheet will be initialed by the person involved and forwarded with the packages. (Form B)

2. Curriculum Development Report. Reports from each design team leader will be forwarded to the administrative assistant each Friday. These reports will identify the aspects of curriculum development completed during that week. In turn, the administrative assistant will compile a summary for all curriculum areas and report to the director the following Monday. (Form C)

V. Documentation

Documentation for an instructional segment is to be made as events occur. A looseleaf notebook should be used and the following included:

A. Hierarchy for objectives

B. Flowchart of strategy

C. Listings

D. Image projector work and/or audio messages

E. Records of macros and dictionaries necessary

F. Validation procedures followed

G. Student use

H. Dates and time required for each phase (Form D)

I. Evaluation procedures followed

A flyer for each segment will be prepared with a resume of the above. Author(s) and programmer(s) will be listed, and the CAI language used will be stated. (Sample flyer - Form E) Samples of flowcharts, image projector slides, and frames will be attached.

VI. Conclusion

The procedures in the curriculum development plan will be followed in this project and the subplan updated when necessary.

FORM A

CHECKLIST FOR REVIEW OF CAI MATERIALS

Unit	____________________	Cost to Project	____________________
Source	____________________	Programming Language	____________________
Date Procured	____________________	Computer	____________________
Design Team	____________________	Student Time	____________________
Reviewer(s)	____________________	Additional Materials	____________________

	Acceptable As Is	Needs to be Written (or Revised) (Estimated Time)
Terminal Objectives		
Enabling Objectives		
Hierarchy		
Criterion Tests		
Pretest		
Post-Test		
Necessary Entering Behaviors		

Comments:

Decision

FORM B

Cover Sheet

MIP Development

COURSE ______________________

UNIT ______________________

MIP TITLE ______________________

	Initial	Date
Author		
Administrative Assistant		
Systems Manager		
Programmer		
Author (Initial Review)		
Programmer		
Author (Final Review)		
MIP Ready for Students		

FORM C

CURRICULUM DEVELOPMENT REPORT

For the week of ____________________, 19___

Design Team ____________________________________

MIP TITLE	Planning	Behavioral Objectives	Entering Behaviors	Test Items	Strategy & Technique	Writing	Instructional Materials	Technical Staff	Author Review	Author Revision	COMMENTS

Total CAI Curriculum hours anticipated by ____________ 1, 19___.
(month)

______________hours.

FORM D

TIME SHEET

MIP NUMBER ____________ DATE INITIATED ____________ DATE COMPLETED ____________

MIP NAME ____________

Draw horizontal lines between original and after each revision.

(Time in hours or fractions of hour)

PLANNING & COGNITION	OBJECTIVES	HIERARCHY	CRITERION TEST	AUTHORING	INSTRUCTIONAL MATERIALS	CODING	DEBUGGING	REVIEWING
						(Take from Terminal Room Log)		
					DOCUMENTATION	DATES	OF VALIDATION	
							Student Use Analysis	
						Initial		
						Completion		
						Initial		
						Completion		

FORM E

Project REFLECT / REsearch into Feasibility of Learnings, Employing Computer Technology

Montgomery County Public Schools CAI Demonstration Project, Rockville, Maryland

RATIO AND PROPORTION

An important mathematical concept, useful in many areas, is that of ratio and proportion. Excellent programs of an elementary nature are available; however, their objective is the solution of simple problems in direct variation. The ability to generalize to other types of variation with a minimum amount of instruction is assumed.

The terminal objective of this instructional segment is:
Given four problems, the student will set up and solve proportions involving direct, joint, inverse, and combined variation.

A pretest and posttest were written. Enabling objectives, a hierarchy, and a flow chart for instructional strategy were prepared.

Instruction is divided into two distinct areas of concern:

1. Identification of variation illustrated in statements
2. Writing of proportions for each type of variation

Tutorial dialogue is used for identification of types of variation. For the setting-up of proportions, the student has the opportunity to follow his own path, retrace his steps when he wishes, and try sample problems.

This segment was used with 14 Albert Einstein High School students, summer 1969.

Author: Catherine E. Morgan
Teacher-Specialist in Curriculum
Programmers: Chris Hoffman
Anne Me[illegible]r
Priscilla Smith
Computer Language: Coursewriter II

8/7/69

APPENDIX B

SUPPLEMENTARY OBJECTIVES FOR PROJECT REFLECT'S TRAINING COURSE

SUPPLEMENTARY OBJECTIVES FOR PROJECT REFLECT'S TRAINING COURSE

The objectives and references listed below are employed in the training program conducted within Project REFLECT. Objectives 1-7 represent the minimum information included in orienting teacher trainees to Montgomery County's CAI Demonstration Project. The attainment of these objectives provides the participants with the background necessary to discuss the project with their colleagures and members of the community. The specific knowledge of the IBM 1500 Instructional System hardware required by a CAI author is indicated in objectives 8-10 which supplement the Computer Fundamentals and Languages objectives on page 127.

OBJECTIVES

At the end of this learning experience, the participant will:

1. Write the definition of Computer-Assisted Instruction as it is used within this project
2. List at least four major objectives of the Computer-Assisted Instruction Demonstration Project
3. Name the major accomplishments that are expected during each of the one-year phases of this project
4. Use a chart to describe the organizational structure of the CAI project and its relationship to the MCPS system
5. Name the areas of primary and secondary curriculum efforts
6. Describe the role of the Supporting Teachers and the function of the Design Teams
7. Describe the location and configuration of the student terminals used in this project
8. Name and describe the four student terminal devices available on the IBM 1500 Instructional System
9. List the four storage devices Project REFLECT has on its IBM 1500 Instructional System and state the type of material that normally is stored on each
10. Given a diagram of the IBM 1500 Instructional System employed in this project, name and describe the function of each component

REFERENCES

"IBM 1500 System Summary." Form Y26-5610-2. New York: International Business Machines, 1967.

Wastler, B. Jean (ed.). Project REFLECT Annual Report, June, 1968 to June, 1969. Rockville, Md.: Montgomery County Public Schools, 1969. 135 pp.

APPENDIX C

COURSEWRITER II

COURSEWRITER II

Developed specifically for the IBM 1500 Instructional System, Coursewriter II was designed so that the average teacher with little or no computer background could learn to do his own programming within a relatively short period of time. While many tutorial programs may be easily coded into the computer, it is, nonetheless, a time-consuming process, using time which the author could better spend developing other lesson segments. In addition, the more complex programs call for advanced techniques requiring the skills of a trained programmer. Therefore, the actual programming of lessons, written by teachers, is done by the technical staff in Project REFLECT.

A basic knowledge of the Coursewriter language, however, is necessary so that the CAI author understands its capabilities and limitations, so that he can lay out his instructional sequences in a form understandable to the programmer, and so that he can utilize the program printouts for review and revision.

OBJECTIVES

At the end of this learning experience, the participant will demonstrate a basic knowledge of Coursewriter II. He will:

1. Sign on a CRT in Coursewriter II author mode, proceed through an instructional sequence using the light pen and the keyboard to make responses and to control the course flow, and sign off the program

2. Sign on a CRT in Coursewriter II author mode and execute a given program sequence

3. Name the five major groups into which the Coursewriter II op codes are divided and describe the function of each group of op codes

4. Given statements describing each of the 19 basic Coursewriter II op codes, write the correct code for each statement and correctly place each code in one of the five major groups

5. Describe the format and function of labels

6. Explain the function of an ep identifier

7. Given an ep identifier guide and information about a frame, correctly construct the ep identifier for the frame

8. Given an Instructional Display Planning Guide, demonstrate the correct layout for each of the following:

    a) Upper and lower case characters
    b) Dt and response insert
    c) Area and spacing for light pen response
    d) Underlining for emphasis and for constructed response
    e) Spacing between lines
    f) Superscripts and subscripts

9. Explain the limitations on the use of graphic material on the CRT

10. Given an IBM 1510 Instructional Display Planning Guide and the content for an enter and process display, correctly construct a frame with the following items included in the instructions to the programmer:

    a) Any change in timing
    b) Answer set
    c) Appropriate display response for each answer
    d) Ep identifier
    e) Presentation sequence control instructions

11. Given a short printout of a Coursewriter II program frame which includes only the basic op codes and an IBM 1510 Instructional Display Planning Guide, correctly lay out the frame described by the printout

12. Describe the procedures for preparing material for the Image Projector and the Audio Unit

COURSEWRITER II - Suggested Procedures

I. Introduction

   A. Provide several opportunities for the participants to operate the student terminals in both the student mode and author mode (execution only) before presenting this topic (objectives 1 and 2).

   B. Distribute the topic description and objectives to the class.

   C. Describe in general terms the characteristics and use of Coursewriter II.

II. Instruction--Use Activities for practice where appropriate.

   A. Supply each participant with a copy of the "IBM 1500 Programming Reference Card."

   B. Provide the class instruction on the format and logic of Coursewriter II (objectives 3-7).

      1. Labels

      2. Operational (op) codes and modifiers (activities 3 and 4)

      3. Parameters (see example A)

      4. Ep identifiers (activity 7)

      5. Functions

      6. HOLD Routine.

   C. Discuss and practice display frame layout (objectives 8-10).

      1. Techniques (See example B--frame layout and frame flowchart.)

      2. Capabilities and limitations of the 1500 Instructional System and the CRT

      3. Instructions to the programmer (activity 10)

   D. Have a programmer demonstrate the coding of a frame.

   E. Explain the use of a printout to debug and document a computer program (see example B--frame printout).

   F. Distribute and discuss the Procedures for Preparing Materials for the Image Projector and Audio Unit (example C)

III. Application--Each participant will lay out the frames for their lesson segment.

IV. Bibliography

A. *IBM 1500 Coursewriter II, Author Guide*. Form Y26-1580-0. New York: International Business Machines Corporation, 1968.

B. "IBM 1500 Programming Reference Card." Form Y26-5700-1. International Business Machines Corporation.

C. "IBM 1500 System Summary." Form Y26-5610-2. New York: International Business Machines Corporation, 1967.

COURSEWRITER II - Author's Guide to Procedures for Image Projector Filmstrip Production

1. Author makes sketch or writes description of specific content* to be photographed or illustrated.

2. Author consults with teacher specialist in instructional materials (TS in IM) and gives her sketch(es) or description(s).

3. TS in IM coordinates production of illustrations or photography work with part-time graphic artist and/or Graphic Arts Section at Washington Center.

4. Author and TS in IM review the work. If necessary, steps 1 - 3 are repeated.

5. Artwork is recycled to Graphic Arts Section for production of 35 mm slides.

6. Slides are reviewed by author and TS in IM.

7. Author arranges slides to match his program plans and numbers them with the addresses provided. (Addresses will be assigned following consultation of project director and systems manager by TS in IM).

8. Author, programmer, and TS in IM review together slide order and addresses.

9. Slides are recycled to Graphic Arts Section for exposure of 16mm film master.

10. Exposed film is sent for processing, and one copy is produced.

11. Author and TS in IM review copy print.

12. Copies of the master are ordered and, when delivered, catalogued and prepared for use.

For additional information:

Procedures for Image Projector Filmstrip Production flyers:
"Basic Rules"
"Guidelines for Content"
"Artwork"
"Photography Work"
"Slides to Filmstrip Procedures"

---

* Obtaining permission for use of copyrighted material is the responsibility of the appropriate design team leader. In the case of copyrighted material, signed permission to use is to accompany the sketch or description in step 2.

COURSEWRITER II - Author's Guide for Preparation of Audio Tape

1. The author creates a script of all audio messages used in the course and indicates the label of the program location each message is to accompany (or follow). Any special directions such as timing or coordination with displays should be clearly specified.

2. The author consults with the Teacher Specialist in Instructional Materials (TS in IM) and gives her the script and indicates choice of narrator.

3. The TS in IM coordinates the production of the narration tape.

4. The narration tape is reviewed by the author and TS in IM.

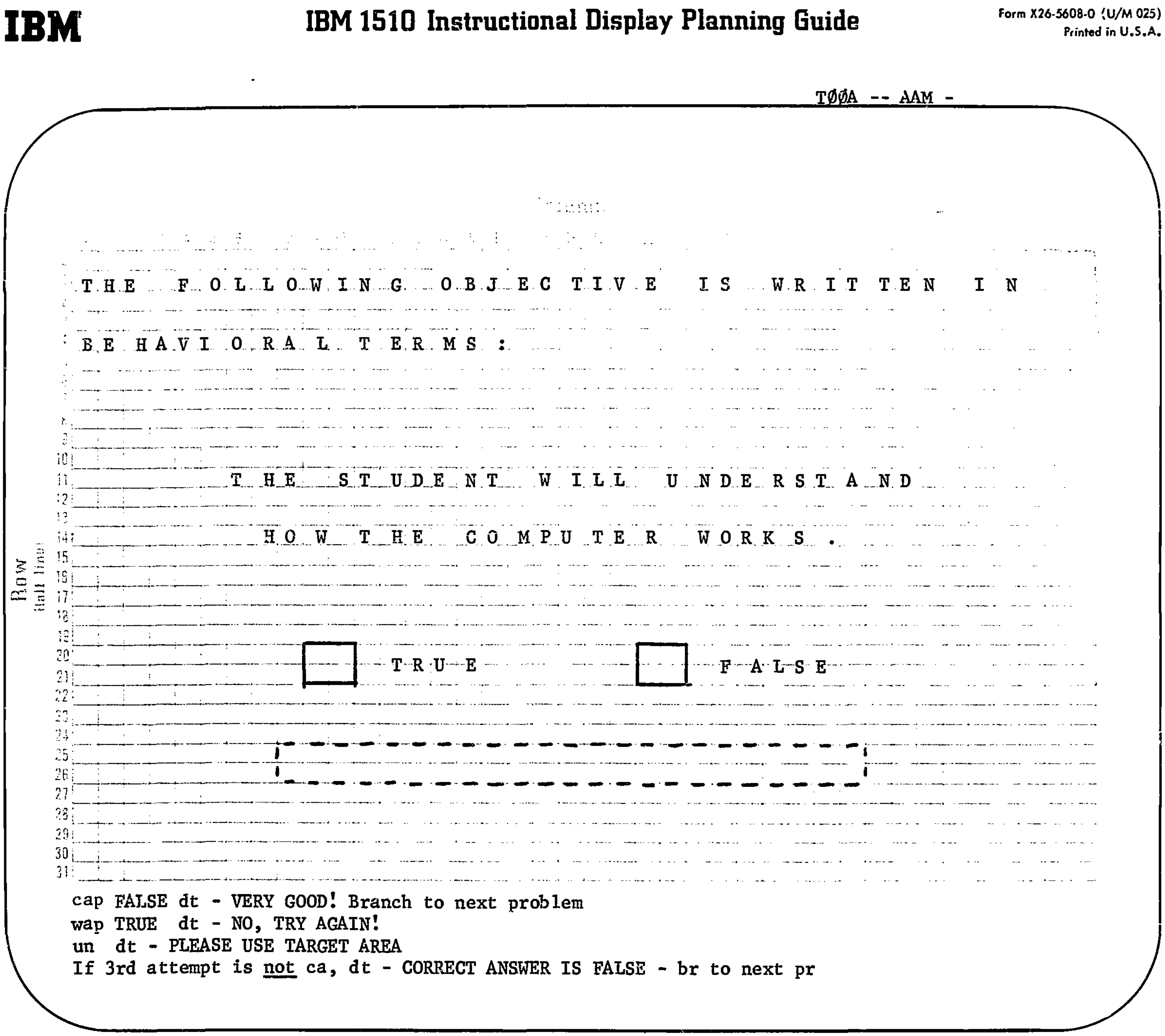
5. The system manager coordinates the audio assembly using an approved narration tape and makes one copy of the master cartridge.

6. The initial copy of the master is reviewed with the course material by the author and the TS in IM to ensure proper audio-course flow has been attained.

7. Additional copies of the approved tape are produced and used. Steps are repeated where necessary.

For the specifics of each step, see Procedures for Preparation of Audio Tapes dated 8/1/69, duplicated MCPS CAI material available on request.

COURSEWRITER II - Example A



IBM

IBM 1510 Instructional Display Planning Guide

Form X26-5608-0 (U/M 025)
Printed in U.S.A.

T00A -- AAM -

THE FOLLOWING OBJECTIVE IS WRITTEN IN

BEHAVIORAL TERMS:

THE STUDENT WILL UNDERSTAND

HOW THE COMPUTER WORKS.

☐ TRUE ☐ FALSE

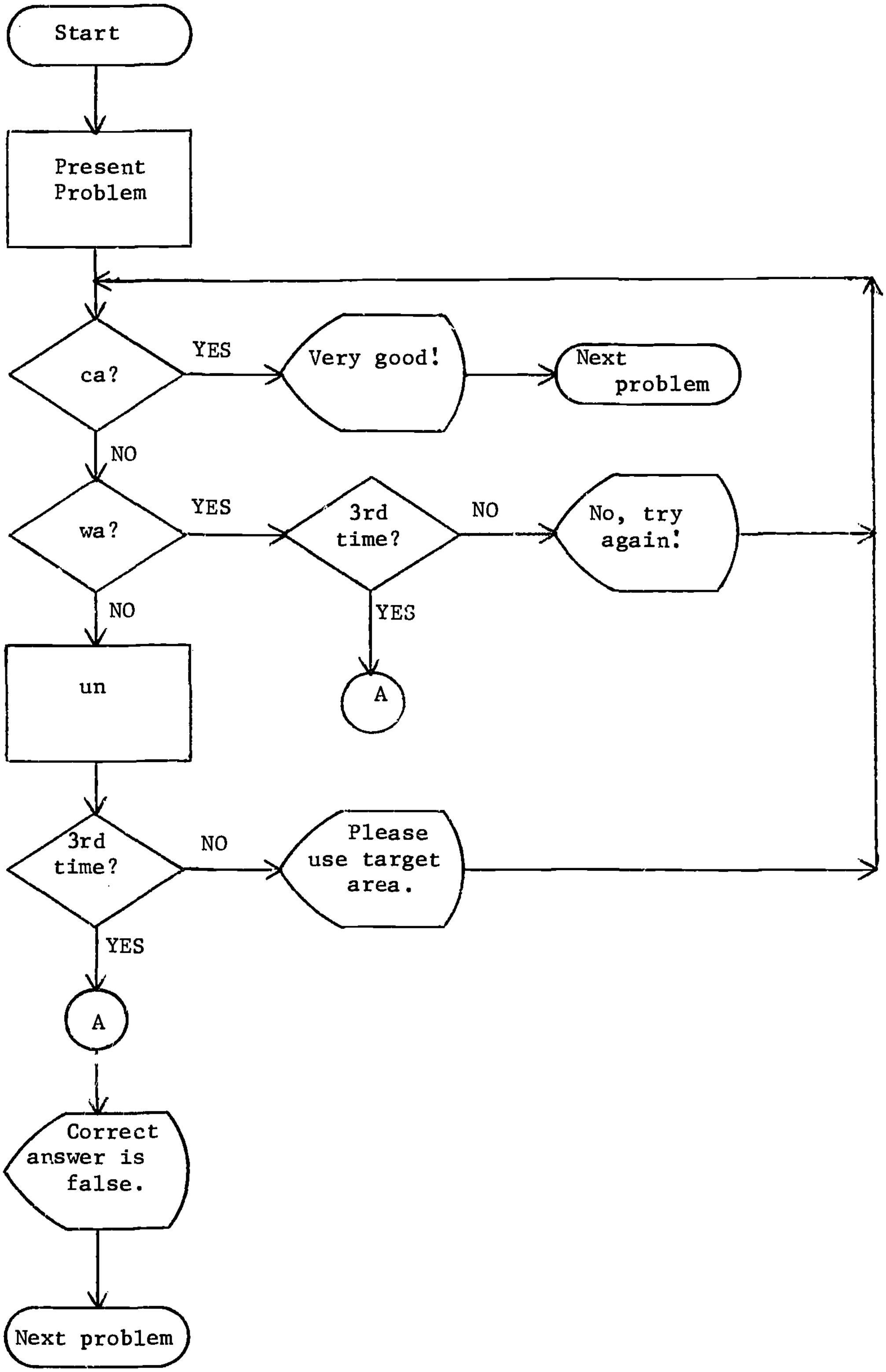
cap FALSE dt - VERY GOOD! Branch to next problem
wap TRUE dt - NO, TRY AGAIN!
un dt - PLEASE USE TARGET AREA
If 3rd attempt is not ca, dt - CORRECT ANSWER IS FALSE - br to next pr

Row
Half line
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

COURSEWRITER II - Example B (frame printout)

```
**410-00 LSTCSE
**TEST  000  TOOAAA                                 00000
TOOAAA*E
    1  PR   *E
    2  LD   0+/C5*E
    3  DE   0+/32*E
    4  DT   0,0+/2,0+/40,0+/(T)HE FOLLOWING OBJECTIVE IS WRITTEN IN*E
    5  DT   3,0+/2,3+/40,0+/BEHAVIORAL TERMS(&*E
    6  DT   10,6+/2,10+/40,0+/(T)HE STUDENT WILL UNDERSTAND*E
    7  DT   13,7+/2,13+/40,0+/HOW THE COMPUTER WORKS.*E
    8  DT   20,9+/2,20+/40,0+/+K+K (TRUE*E
    9  DTI  20,22+/2,20+/18,22+/+K+K (FALSE*E
   10  EPP  +/TOOAAAAAM1*E
   11  NX   *E
   12  BR   RE*E
   13  CAP  4,19,4,21+/C1*E
   14  DT   25,8+/2,25+/40,0+/(V)ERY (G)OOD(6*E
   15  PA   30*E
   16  BR   TOOAAB*E
   17  WAP  4,19,4,8+/W1*E
   18  AD   1+/C5*E
   19  BR   3WRONG+/C5+/E+/3*E
   20  DT   25,8+/2,25+/40,0+/(N)O, TRY AGAIN(6*E
   21  PA   30*E
   22  DE   25+/2*E
   23  BR   RE*E
   24  UN   UU*E
   25  AD   1+/C5*E
   26  BR   3WRONG+/C5+/E+/3*E
   27  DT   25,8+/2,25+/40,0+/(PLEASE USE TARGET AREA*E
   28  PA   30*E
   29  DE   25+/2*E
   30  BR   RE*E
3WRONG*E
    1  DT   25,8+/2,25+/40,0+/(C)ORRECT (A)NSWER IS (FALSE*E
    2  PA   30*E
    3  BR   TOOAAB*E
    4  EN   *E
```

COURSEWRITER - Example B (frame flowchart)


Start
Present Problem
ca?
YES
Very good!
Next problem
NO
wa?
YES
3rd time?
NO
No, try again!
YES
A
NO
un
3rd time?
NO
Please use target area.
YES
A
Correct answer is false.
Next problem

COURSEWRITER II - Activity 3*

Name the five major groups into which the Coursewriter II op codes are divided and describe the function of each.

1. ______________________________

____

____

2. ______________________________

____

____

3. ______________________________

____

____

4. ______________________________

____

____

5. ______________________________

____

____

---

* Since activities are keyed to objectives and the activities for some objectives are obvious, not all activities are provided here.

COURSEWRITER II - Activity 4

For each of the Coursewriter II instructions named below:

(1) Write the correct op code in the proper space.
(2) Using the list of MAJOR GROUPS in which each instruction belongs, write the number of the correct group in the space provided.

Major Groups

1. Problem presentation
2. Presentation sequence control
3. Response requests
4. Response analysis
5. Scorekeeping
6. Other

Op Code	Group	Instruction
________	________	display text insert
________	________	correct answer
________	________	synonymous wrong answer
________	________	problem start
________	________	add
________	________	enter and process responses from keyboard
________	________	no execute
________	________	wrong answer
________	________	display text
________	________	unrecognizable response
________	________	display erase
________	________	synonymous correct answer
________	________	pause
________	________	load
________	________	branch
________	________	problem restart
________	________	call function
________	________	enter and process response from light pen

COURSEWRITER II - Activity 7

Using the guide provided, entitled EP IDENTIFIER, write the correct ep identifier for the frame described below.

This frame appears within the second tutorial program developed for seventh grade geography. The frame is designed to measure a student's attainment of a lesson objective identified as AB.

____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Write ep identifier in spaces above.

COURSEWRITER II - Activity 7 (continued)

EP IDENTIFIER

1/	Label			A A/N	2/
Course	Grade	MIP ID	Programmer's ID	MIP Objectives	Type of Question and Instruction

---

1/ COURSE IDENTIFICATION

A Arithmetic
B
C Chemistry
D Demonstration
E ESCP
F French
G Geography
H History
I

J
K
L Language Arts
M Mathematics
N
O
P Physics
Q
R

S Science
T Teacher's Training
U
V
W
X
Y
Z Summer Math/Science

2/ Type of Test Question		Type of Instruction: Drill and Practice		Tutorial		Simulation		Problem Solving
Pretest		B		K		S		2
Post-Test		D		M		U		4
Diagnostic	E*	F	N*	O	V*	W	5*	6
Instructional		H		Q		Y		8
Criterion		I		R		Z		9

*Entering Behavior

Counter will show test question format.

COURSEWRITER II - Activity 8

Correctly lay out the following material on the IBM 1510 Instructional Display Planning Guide which is provided.

Please type your first name. __________________

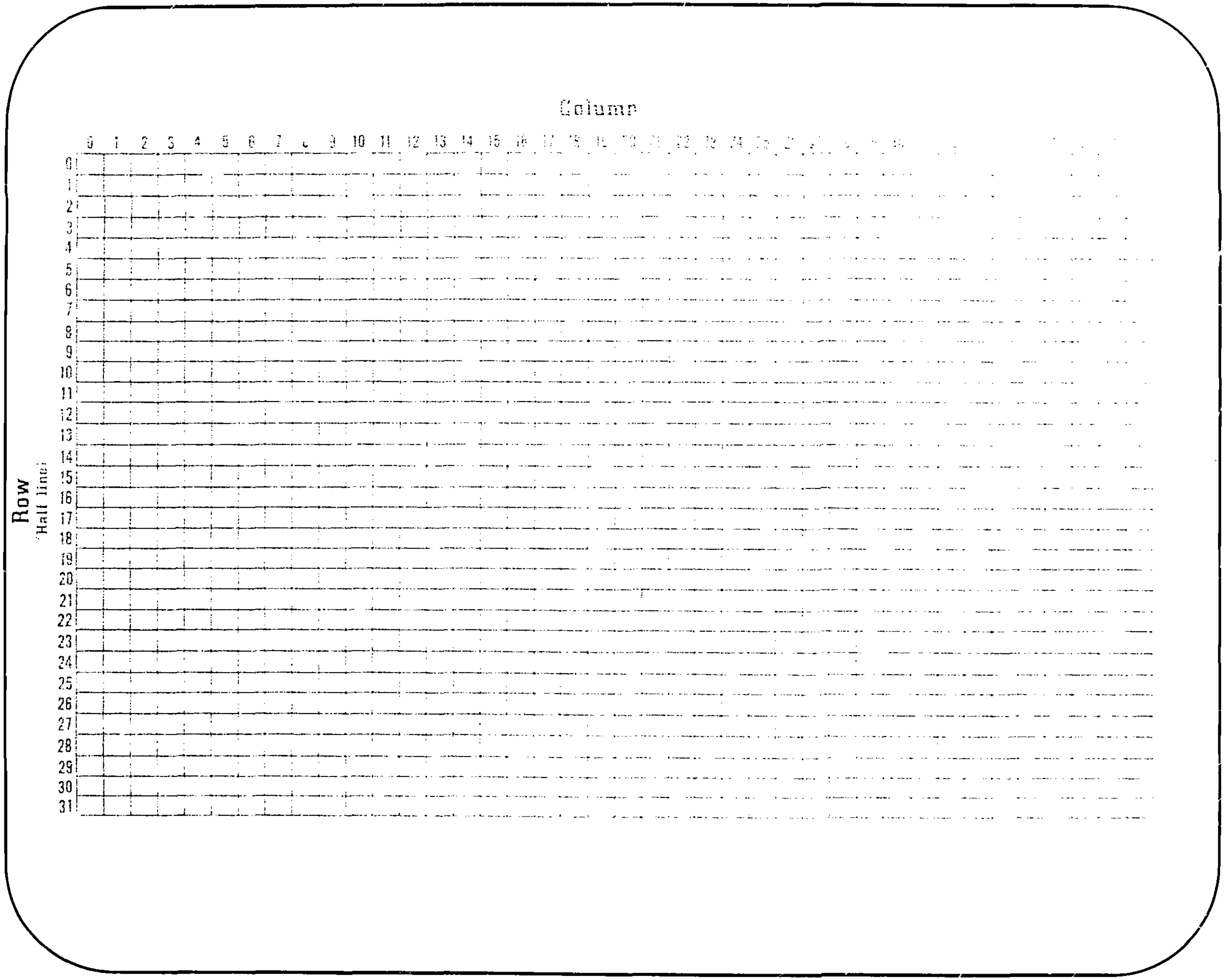
Hello (allow for insert), today you are demonstrating your knowledge of COURSEWRITER II layout techniques. You need to know how to indicate subscripts and superscripts to write formulas like H_2O and powers like 10^5. Two columns and two rows are required on all sides of a response area for use of the light pen.

TRUE FALSE

IBM

IBM 1510 Instructional Display Planning Guide

Form X26-5608-0 (U/M 025)
Printed in U.S.A.


Column
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Row
(Half line)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

COURSEWRITER II - Activity 10

The content for two enter and process frames is stated below. The first frame requires a constructed response, and the second is a multiple-choice question.

Using the IBM 1510 Instructional Display Planning Guides provided, correctly lay out the two frames. Include all instructions necessary for coding the frames.

1.

In a programmed frame, the information or clues that help a learner respond in the desired manner is the stimulus. The portion of the frame which requires the learner's participation is called the ______________________.

2.

The "father" of linear programmed instruction is generally agreed to be: Crowder, Mager, Markle, or Skinner.

COURSEWRITER II - Activity 11

Using the printout of the frame below, lay it out on a Display Planning Guide.

```
DEMOBP*E
   1  PR   *E
   2  PRR *E
   3  DE   0+/32*E
   4  DT   3,3+/2,3+/40,0+/(L)OOK AT PAGE 15*B*B(--)IN THE FLIPBOOK.*E
   5  DT   7,6+/2,7+/40,0+/(N)OTICE THAT THE FIXED SCALE IS*E
   6  DT   9,2+/2,9+/40,0+/NOT MOVABLE AND THAT IT CONTAINS*E
   7  DT   11,2+/2,11+/40,0+/BOTH (E)ENGLISH AND METRIC UNITS.*E
   8  DT   16,6+/2,16+/40,0+/(T)HE SCALE WHICH (DOES MOVE) MUST*E
   9  DT   19,6+/2,19+/40,0+/BE CALLED THE            SCALE.*E
  10  DT   21,20+/2,21+/40 ,0+/+M+M+M+M+M+M+M+M+M*E
  11  EPI 19,20+/2,19+/9,20+/+/99+/DEMOBPA3Q4*E
  12  NX   *E
  13  BR   RE*E
  14  FN2 EDIT+/ALL+/*R*B+/*E
  15  CA   VERNIER+/C1*E
  16  AD   1+/C1*E
  17  DT   22,21+/2,22+/40 ,0+/(G)OOD REASONING(6*E
  18  PA   30*E
  19  BR   DEMOBQ*E
  20  WA   MOVABLE+/W1*E
  21  WB   MOVEABLE+/W2*E
  22  AD   1+/C2*E
  23  DT   26,0+/2,26+/40,0+/(T)HAT'S A LOGICAL ANSWER, BUT BE MORE*E
  24  DT   28,3+/2,28+/40,0+/SPECIFIC.*E
  25  PA   50*E
  26  DE   24+/4*E
  27  BR   RE*E
  28  UN   U1*E
  29  AD   1+/C3*E
  30  DTI 19,20+/2,19+/9,20+/VERNIER*E
  31  PA   5*E
  32  DTI 16,22+/2,16+/9,22+/*E
  33  DTI 19,20+/2,19+/7,20+/*E
  34  PA   3*E
  35  DTI 16,22+/2,16+/9,22+/(DOES MOVE*E
  36  DTI 19,20+/2 ,19+/7,20+/VERNIER*E
  37  PA   5*E
  38  DTI 16,22+/2,16+/9,22+/*E
  39  DTI 19,20+/2,19+/7,20+/*E
  40  PA   3*E
  41  DTI 16,22+/2,16+/9,22+/(DOES MOVE*E
  42  DTI 19,20+/2 ,19+/7,20+/VERNIER*E
  43  PA   5*E
  44  DTI 16,22+/2,16+/9,22+/*E
  45  DTI 19,20+/2,19+/7,20+/*E
  46  PA   3*E
  47  DTI 16,22+/2,16+/9,22+/(DOES MOVE*E
  48  DTI 19,20+/2,19+/7,20+/VERNIER*E
  49  PA   20*E
  50  BR   DEMOBQ*E
DEMOBQ*E
```

APPENDIX D

A PROGRAMMING LANGUAGE

A PROGRAMMING LANGUAGE

A Programming Language (APL) is a dual purpose computer language. Of prime importance is its use as a powerful calculator in both primitive and defined function modes. APL has limited secondary value as a tutorial language with some capabilities for drill and practice and for simulation.

Individual levels of mathematical competence and sophistication will determine APL's usefulness to a participant in this program. A person should investigate those functions related to his experiences, taking into consideration his mathematical and statistical needs as well as the instructional possibilities.

OBJECTIVES

At the end of this learning experience, the participant will:

1. Distinguish between scalars and vectors.
2. Use those monadic and dyadic functions which represent common mathematical operations used in the classroom.
3. Using an APL manual, sign on an APL terminal, input simple problems in the desk calculator mode, obtain both scalar and vector answers, and sign off the terminal.
4. Sign on an APL terminal, name a program, input a program which includes at least one textual statement, correct errors, and store the program for future use.
5. Clear a workspace, display the contents of a program, edit a program, input values for a program, and use the program.

A PROGRAMMING LANGUAGE - Suggested Procedures

I. Introduction

A. Provide class with copies of topic description and objectives and the Self-Instructional APL Booklet (included in this section).

B. Discuss the uses of APL in the instructional setting.

II. Instruction--Each unit may be followed by practice.

A. Demonstrate mechanics of terminal use, pointing up similarities and differences between Coursewriter II and APL.

B. Display and discuss the APL keyboard and symbols.

C. Define and show simple examples of each of the following:

1. Arguments
2. Scalars and vectors
3. Primitive functions
4. Defined functions

III. Practice

A. Using the self-instructional booklet, participants will work on those items on the investigation sheets within the individual's interests and mathematical knowledge.

B. Discussion and individual interaction to check sheets and answer individual questions.

IV. Bibliography

A. Krueger, S. E. and McMurchie, T. D. A Programming Language/1500. Chicago: Science Research Associates, 1968.

B. Morgan, Kay. "A Programming Language: Self-Instructional Unit." Kensington, Maryland: Project REFLECT, 1969.

A
PROGRAMMING
LANGUAGE

SELF-INSTRUCTIONAL UNIT
BY KAY MORGAN
1969

APL FOR USE WITH IBM 1500 *INSTRUCTIONAL SYSTEM WITH AN* 1130 *CENTRAL PROCESSING UNIT*

APL A PROGRAMMING LANGUAGE

GENERAL INFORMATION

PART I

KEYBOARD

NUMERALS, LETTERS, AND PUNCTUATION MARKS APPEAR AS USUALLY FOUND ON ANY TYPEWRITER KEYBOARD. HOWEVER, LETTERS ARE ALL IN CAPITALS AND ARE MADE WITHOUT SHIFTING. A SAMPLE KEYBOARD FOLLOWS THIS PAGE. TO HELP YOU AT THE TERMINAL, THE APL SYMBOLS ARE PRINTED AND PASTED IN FRONT OF EACH KEY.

COMMUNICATION

COMMUNICATION BETWEEN THE TERMINAL AND THE COMPUTER OCCURS WHEN ENTRIES ARE MADE FROM THE KEYBOARD. AFTER TYPING AN INSTRUCTION, PRESS THE 'RETURN' KEY TO INDICATE THE END OF THE COMMAND.

ERRORS IN TYPING

ERRORS IN TYPING CAN BE CORRECTED BEFORE ENTERING BY THE FOLLOWING PROCEDURES:

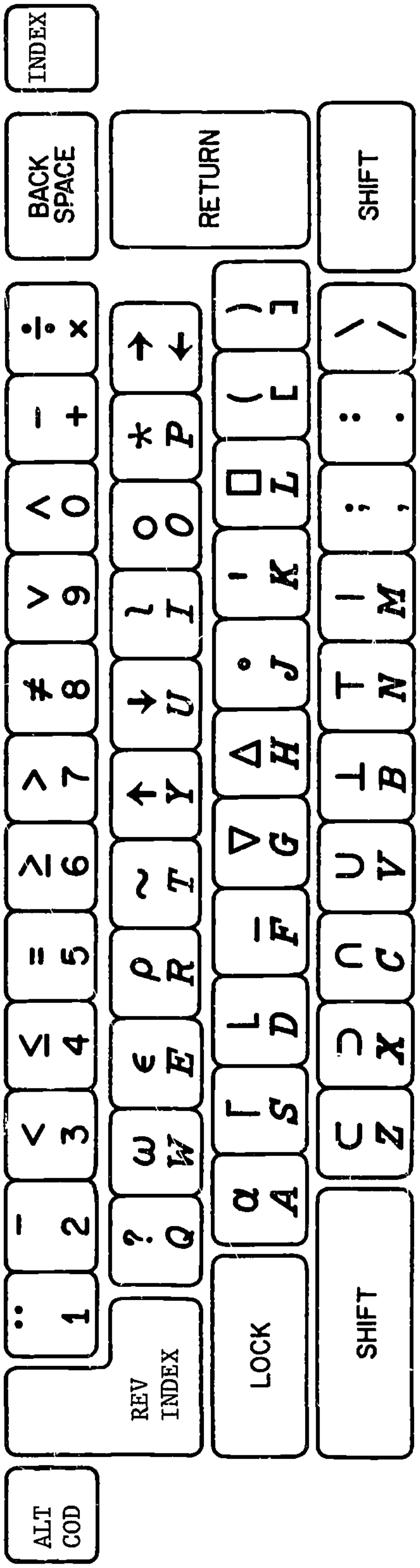
(1) BACKSPACE TO POINT OF ERROR, DEPRESS THE INDEX KEY - THIS WILL ERASE EVERY SYMBOL TO THE RIGHT OF AND INCLUDING THE CURSOR. (FOR TYPEWRITER)

(2) DEPRESS THE PLUS + KEY AND THE ALT CODE KEY AT THE SAME TIME - THIS WILL ERASE THE ENTIRE LINE. (FOR CRT)

(3) DEPRESS THE ALT CODE KEY AND BACKSPACE - THIS WILL ERASE EACH SYMBOL AS YOU BACKSPACE. (FOR CRT)

CONTINUATION

IF YOUR INSTRUCTION IS LONGER THAN ONE LINE, YOU MAY CONTINUE ON THE NEXT LINE BY PRESSING THE ALT CODE KEY AND THE RETURN KEY AT THE SAME TIME.


ALT COD
¨ 1
¯ 2
< 3
≤ 4
= 5
≥ 6
> 7
≠ 8
∨ 9
∧ 0
- +
÷ ×
BACK SPACE
INDEX
REV INDEX
? Q
ω W
∊ E
ρ R
~ T
↑ Y
↓ U
⍳ I
○ O
⋆ P
← →
RETURN
LOCK
α A
⌈ S
⌊ D
_ F
∇ G
∆ H
∘ J
' K
⎕ L
([
)]
SHIFT
⊂ Z
⊃ X
∩ C
∪ V
⊥ B
⊤ N
| M
; ,
: .
\ /
SHIFT

APL KEYBOARD

TO GAIN ATTENTION OF THE COMPUTER

DEPRESS THE ALT CODE KEY AND THE INDEX KEY AT THE SAME TIME.

TO SIGN ON

GET THE ATTENTION OF THE COMPUTER AS DESCRIBED ABOVE AND THEN TYPE)YOUR APL NUMBER AND PRESS THE RETURN KEY.

EXAMPLE:)348724

THIS ALLOWS YOU A WORKSPACE IN THE COMPUTER SIMILAR TO A PRIVATE SCRATCH PAD AND A PERSONAL NOTEBOOK.

AS SOON AS YOU ARE SIGNED ON, THE FULL APL SYSTEM IS AVAILABLE FOR YOUR USE.

TO SIGN OFF

TYPE)OFF AND PRESS THE RETURN KEY.

PART II

STATEMENTS TO THE COMPUTER ARE OF TWO TYPES:

PRIMITIVE FUNCTIONS WHICH ARE PROVIDED BY THE SYSTEM. SOME OF THESE WILL BE LEARNED BY EXPERIMENTATION. SECTION A BELOW DISCUSSES PRIMITIVE FUNCTIONS.

DEFINED FUNCTIONS WHICH YOU, THE USER, PROVIDE BY ENTERING DEFINITIONS OF PROGRAMS. SECTION B ON PAGE 6 EXPLAINS DEFINED FUNCTIONS.

A. PRIMITIVE FUNCTIONS

YOU ARE TO INVESTIGATE THE PRIMITIVE FUNCTIONS OF THE SYSTEM FIRST. TO ASSIST YOU IN LEARNING APL, FOUR INVESTIGATION SHEETS ARE INCLUDED AT THE END IN THIS BOOKLET. THESE SHEETS CONTAIN DIRECTIONS FOR THEIR USE.

PRIMITIVE FUNCTIONS WITH ONLY ONE ARGUMENT (OR NUMBER) SUCH AS
!A ÷A ARE CALLED MONADIC FUNCTIONS.

THOSE FUNCTIONS WHICH REQUIRE TWO ARGUMENTS (OR NUMBERS) SUCH AS
A÷B A*B ARE CALLED DYADIC FUNCTIONS.

WORK ON INVESTIGATION WHEET NO. 1 UNTIL YOU ARE SATISFIED THAT YOU KNOW WHAT EACH OF THE GIVEN APL COMMANDS IS DOING.

INVESTIGATION SHEET NO. 2 ALLOWS YOU TO DISCOVER HOW APL TREATS SCALARS AND VECTORS. IT FURTHER ASKS YOU TO DISCOVER WHAT APL DOES WITH STATEMENTS OF LOGIC.

SINGLE NUMBERS SUCH AS
17
3.14159
¯10
3000000

ARE CALLED SCALARS.

LISTS OF TWO OR MORE NUMBERS SUCH AS
7, 3, 42, .34, 9000000
¯49, .111111111

ARE CALLED VECTORS

INVESTIGATION SHEET NO. 3 ALLOWS YOU TO DISCOVER THE ORDER IN WHICH APL COMPUTES WHEN NO PARENTHESES ARE USED.

THE ORDER OF OPERATIONS USED IN APL IS DIFFERENT FROM THAT USED IN MATHEMATICS. OF COURSE, IF PARENTHESES ARE USED IN EXPRESSIONS, THEN THE RESULTS ARE IDENTICAL.

INVESTIGATION SHEET NO. 4 ILLUSTRATES SOME COMMON ERRORS AND THE ERROR MESSAGES SENT BY THE COMPUTER.

ALTHOUGH ERROR MESSAGES CAN BE IGNORED WHEN YOU ARE USING THE COMPUTER AS YOU HAVE BEEN, IT IS IMPORTANT TO BE ABLE TO CORRECT ERRORS WHEN IN FUNCTION DEFINITION MODE.

SOME MORE GENERAL INFORMATION - SUPPOSE YOUR WORKSPACE BECOMES FULL - THE COMPUTER WILL SEND YOU A MESSAGE.

```
WS FULL
```

IF YOU RECEIVE SUCH A MESSAGE, TYPE `)CLEAR` AND YOU WILL HAVE A CLEAN WORKSPACE INSIDE THE COMPUTER.

THIS MESSAGE WILL NOT CLEAR UP A MESSY SCREEN. YOU NEED TO TYPE ⌹0 (DOMINO ZERO) FIRST YOU TYPE ⎕, BACKSPACE, TYPE ÷, AND THEN 0.

B. DEFINED FUNCTIONS

AT THIS POINT YOU ARE READY TO WRITE A PROGRAM WHICH YOU MIGHT USE MORE THAN ONCE AND WHICH YOU MIGHT WISH TO STORE IN THE COMPUTER.

SUPPOSE YOU WISH TO WRITE A PROGRAM WHICH WILL COMPUTE THE AVERAGE OF A GROUP OF TEST SCORES, PLUS SOME OTHER INFORMATION. LET'S CALL THIS PROGRAM A. FIRST YOU MUST TYPE `)LOAD` THEN, TYPE `∇A` (CALLED DEL A). THE COMPUTER THEN PRINTS [1] AND YOU TYPE YOUR FIRST STATEMENT.

```
∇A
[1]  'THE NUMBER OF SCORES IS'
[2]  ρS
[3]  'THE HIGHEST SCORE IS'
[4]  ⌈/S
[5]  'THE LOWEST SCORE IS'
[6]  ⌊/S
[7]  'THE AVERAGE SCORE IS'
[8]  +/S÷ρS
[9] ∇
```

LET'S USE OUR PROGRAM.

FIRST TYPE A VECTOR OF SCORES FOR S

```
S←90  86  72  65  100  88  85  92
```

THEN TYPE A

ON THE SCREEN WILL APPEAR THE FOLLOWING:

```
    THE NUMBER OF SCORES IS

    8

    THE HIGHEST SCORE IS

    100

    THE LOWEST SCORE IS

    65

    THE AVERAGE SCORE IS

    84.75
```

IF THE PROGRAM WORKS THE WAY YOU WISH, AND YOU WISH TO STORE IT IN THE COMPUTER, TYPE)SAVE

IF YOU WISH TO VIEW WHAT YOU WROTE, TYPE

```
∇A[⎕]∇
```

AND THE PROGRAM WILL BE DISPLAYED.

IF YOU WISH TO MAKE AN ADDITION TO YOUR PROGRAM, TYPE

```
∇A
```

AND THE COMPUTER WILL PRINT [9] AND YOU CAN ADD ANY STEPS YOU WISH.

IF YOU WISH TO CHANGE STEP 4, TYPE ∇A AND WHEN [9] APPEARS, TYPE [4] NEXT TO THE [9] AND THEN TYPE STEP 4 AS YOU WISH TO CHANGE IT.

THEN

[5] WILL APPEAR ON THE SCREEN AND YOU MAY CHANGE STEP 5. IF YOU WANT TO LEAVE STEP 5 AS IT WAS ORIGINALLY, TYPE ∇.

ERRORS IN DEFINITIONS MUST BE CORRECTED. TO DO SO AFTER YOU RECEIVE AN ERROR MESSAGE FOR A CERTAIN LINE, YOU MUST TYPE)PURGE TO BE ABLE TO MAKE CORRECTIONS.

PEOPLE WHO USE APL HAVE MORE FUN!

INVESTIGATION SHEET NO. 1

USE RATIONAL NUMBERS FOR A, B, C ... TRY A VARIETY OF NUMBERS IN YOUR DISCOVERY OF WHAT THE FUNCTION DOES. WRITE IN THE SPACE PROVIDED WHAT FUNCTION EACH COMMAND DOES. TWO FUNCTIONS HAVE BEEN FILLED IN.

TYPE	*FUNCTION*
A+B	A+B
A-B	
A×B	
A÷B	
+A	A + 0
-A	
÷A	
A*B	
A⌈B	
A⌊B	
A?B	
⌈A	
⌊A	
|A	
!A	
?A	
○A	

INVESTIGATION SHEET NO. 2

TYPE	FUNCTION
ι A (IOTA - SHIFTED I)	
ρ A B C (RHO - SHIFTED R)	
A + B C D E	
A B C × D E F	
A * B C D	
A ÷ ιB	
+/ A B C D	
×/ιA	
LOGIC	
A > B	
A < B	
A = B	
A ≠ B	
A ≥ B	
A ≤ B	

INVESTIGATION SHEET NO. 3

EXPRESSION	MATHEMATICAL NAME	APL NAME	WRITE THE EXPRESSION WITH THE LEAST NUMBER OF PARENTHESES THAT WILL NORMALLY GIVE THE SAME ANSWER
7+4-5			
8+2×6			
8^2+6			
14×2÷10+1			
4÷3×3.14×7*3			
2×2*3			
2*2×3			
1130+.25+6732.57-6000			
6*2×7+9÷¯3			

REARRANGE THESE EXPRESSIONS SO THEY WILL GIVE THE INTENDED RESULTS IN APL, USING NO PARENTHESES.

3÷5×10	6
3×5+6	21
3-1+4×8	40
75-31×.1+15	19.4

INVESTIGATION SHEET NO. 4

ERROR MESSAGES

TYPE	*MESSAGE*	*REASON*
A×7		
JOHN		
7÷0		
7?3		
3 2 6 + 7 8		
ι400		

A PROGRAMMING LANGUAGE - Criterion Items

1. Name each of the following sets as either Scalar, S, or Vector, V.

   a. 7.1432

   b. 9 7 3

   c. 401 .72 3/7

   d. 562491

   e. 1 2 3 4 5 6

2. Using APL in primitive function mode, write the simplest name for each of the following, and state what mathematical operation was performed.

   a. 5

   b. 3.1416

   c. 3 * 5

   d. 14 3

   e. -3 -1

   f. 30

3. Without the use of terminal, write answers by computing in the way APL does.

   a. +/ 10

   b. 5 6 3 10 2 3

   c. 4 * 1 3 4

   d. 7 x 4 + 2

   e. 7 * 8 4

4. Sign on APL, name a program, and input a program to find the average of a set of numbers which includes one textual statement and store for future use.

5. After using APL for calculations or defined programs, clear workspace, display contents of program written to find averages, change at least one statement, put values in for program, and display results.

APPENDIX E

KEY TO LEARNING ACTIVITIES

KEY TO LEARNING ACTIVITIES

Most of the activities employed in this manual may be answered or completed in a variety of ways. Rarely is there any one correct solution or method for accomplishing objectives. The answers supplied in this section are suggested solutions for the exercises and are not the only acceptable solutions or responses which the participants may supply.

Instructional Objectives and Criterion Tests - -

Key to activities on pp. 29-41

1. 2, 3, 4, 6, 8, 12, 14, 17, 19, and 20.

2. Use action verbs describing what the student will actually do - - identify, name, list, construct, etc.

3. Within a maximum of six minutes, using a globe with five cities clearly indicated, the student will correctly name, with not more than a two-degree error, the latitude and longitude coordinates for each city.

4. The student will write the letters of the alphabet as each letter is presented orally.

5. The student will fill in on a map the names of each state and of the 20 largest cities in the United States given a map with the states outlined and the cities designated by a star. The names must be correctly spelled and completed in a single attempt.

6. Given a paragraph with ten capitalization errors; the student will correct the errors with 90 per cent accuracy.

7. See introductory paragraph on p. 25.

8. After viewing the film "(title)," the student will list from memory at least three motivating factors that lead to the use of alcohol, narcotics, and tobacco.

9. a.

10. b. Listing the steps is not the same as actually inscribing the circle within the triangle.

    c. Since a student would normally learn and practice this skill at his desk, the only valid measure of its attainment would be to test the student under the same conditions. Performance required differs also.

11. Using the four multiplication sentences below, list the product and factors for each sentence in the spaces provided.

    (1) $2 \times 3 = 6$ (2) $28 = 7 \times 4$ (3) $9 \times (2 \times 2) = 36$
    (4) $48 = (4 \times 2) \times (3 \times 2)$

11. (con't.)

	Factors	Products
1.	________________________	________________________
2.	________________________	________________________
3.	________________________	________________________
4.	________________________	________________________

12. Activities 3 and 5 are examples of well-written objectives.

Constructing Hierarchies - - Key to activities on pp. 55-69.

1. See objective 11 on p. 43.

2. is a state which exists when the performance of the terminal objective occurs under the same conditions as the performance of the enabling objectives.

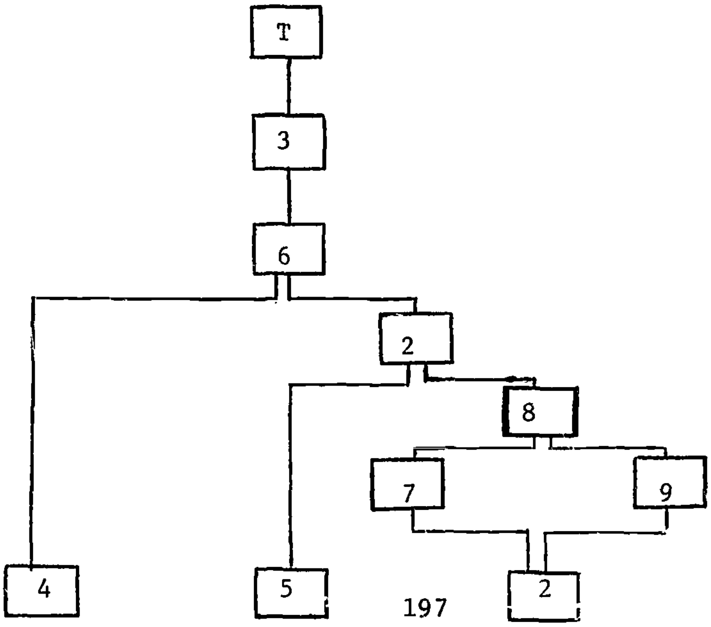
3. 5

4. Given an automobile with one flat tire and the equipment necessary for safely changing it stored in the trunk, the student will change the tire and correctly store the flat tire and the equipment within 20 minutes.

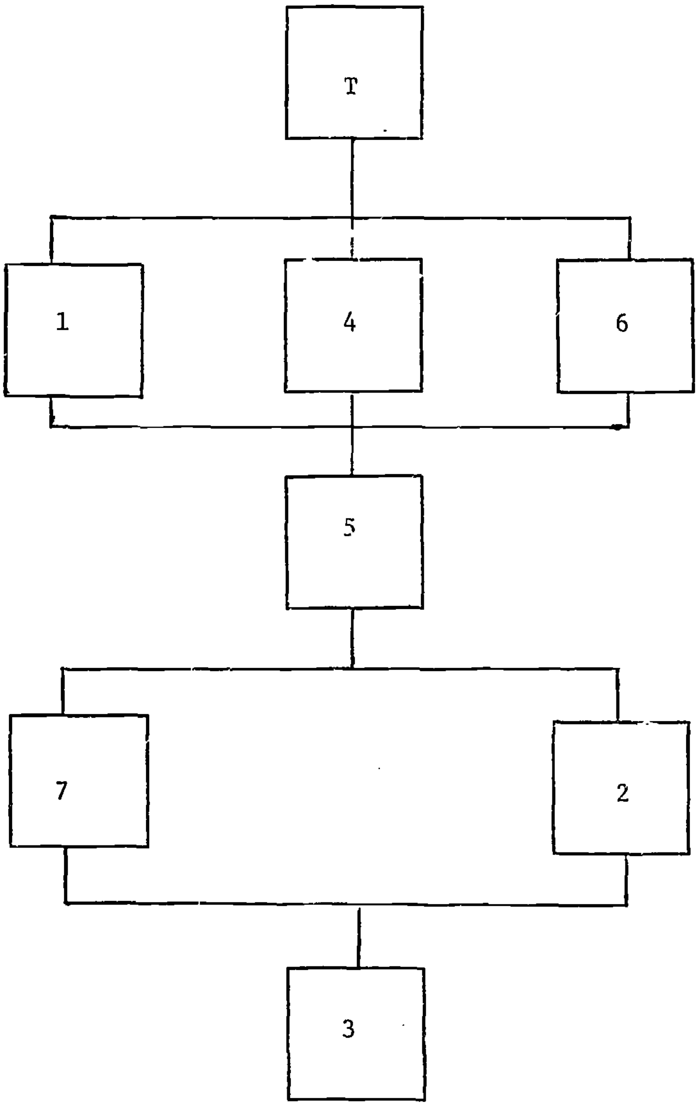
5. G-2

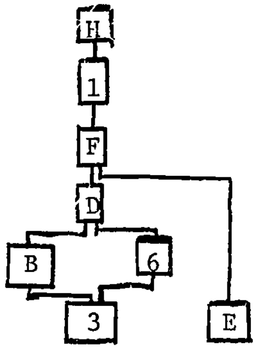
6. State the rule for finding the greatest possible error in linear measurement.

7.



8.





10. B. Given a vernier caliper, identify the outside calipers.

    D. Given a vernier caliper, identify the depth gauge.

    E. Given a vernier caliper, distinguish among the inside calipers, the outside calipers, and the depth gauge.

Flowcharting -- Key to activities on pp. 76-87.

1. REFLECT (Acronym for the Montgomery County Public Schools CAI Project. Other letters may be substituted.)

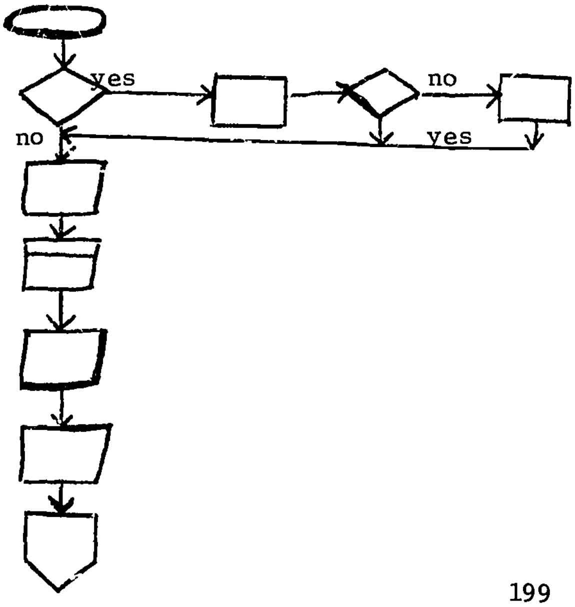
2. See Basic Flowcharting Symbols on p. 73.

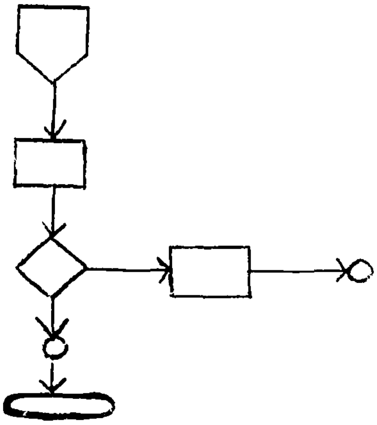
3. See p. 73.

4. See p. 73.

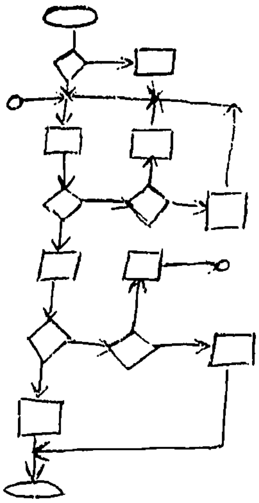
5. See p. 73.

6.



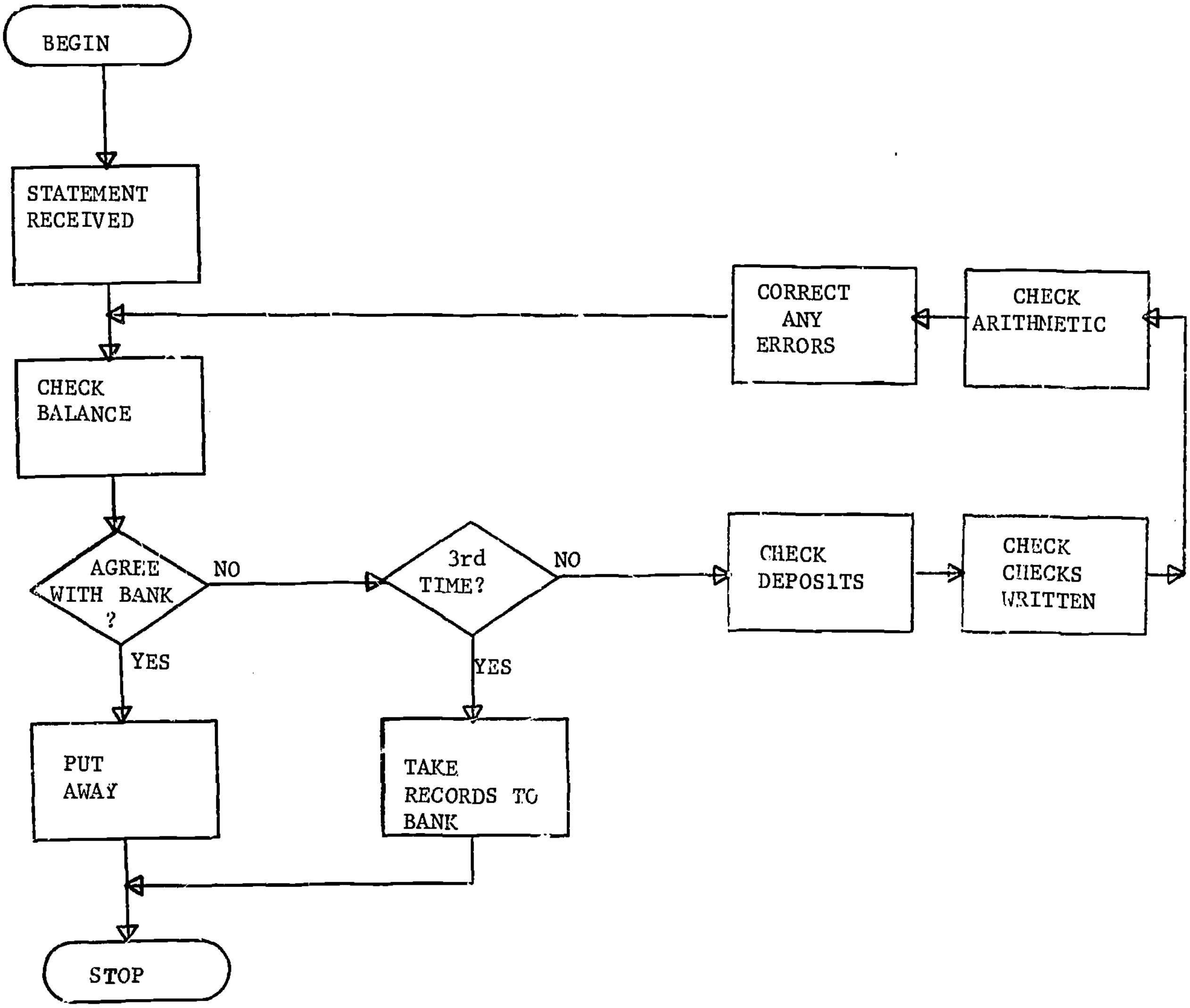


7.

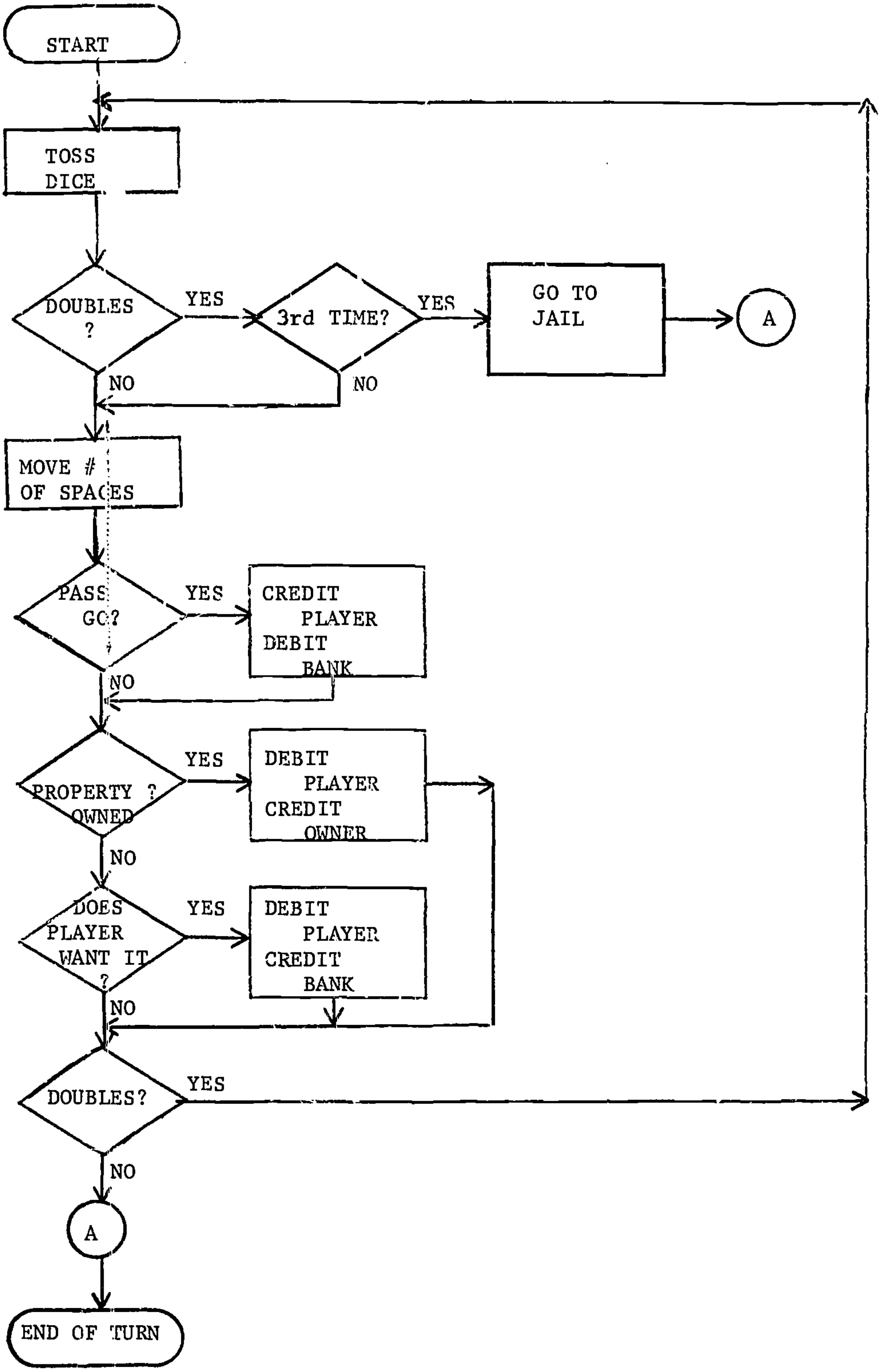


8. See p. 70.

9.

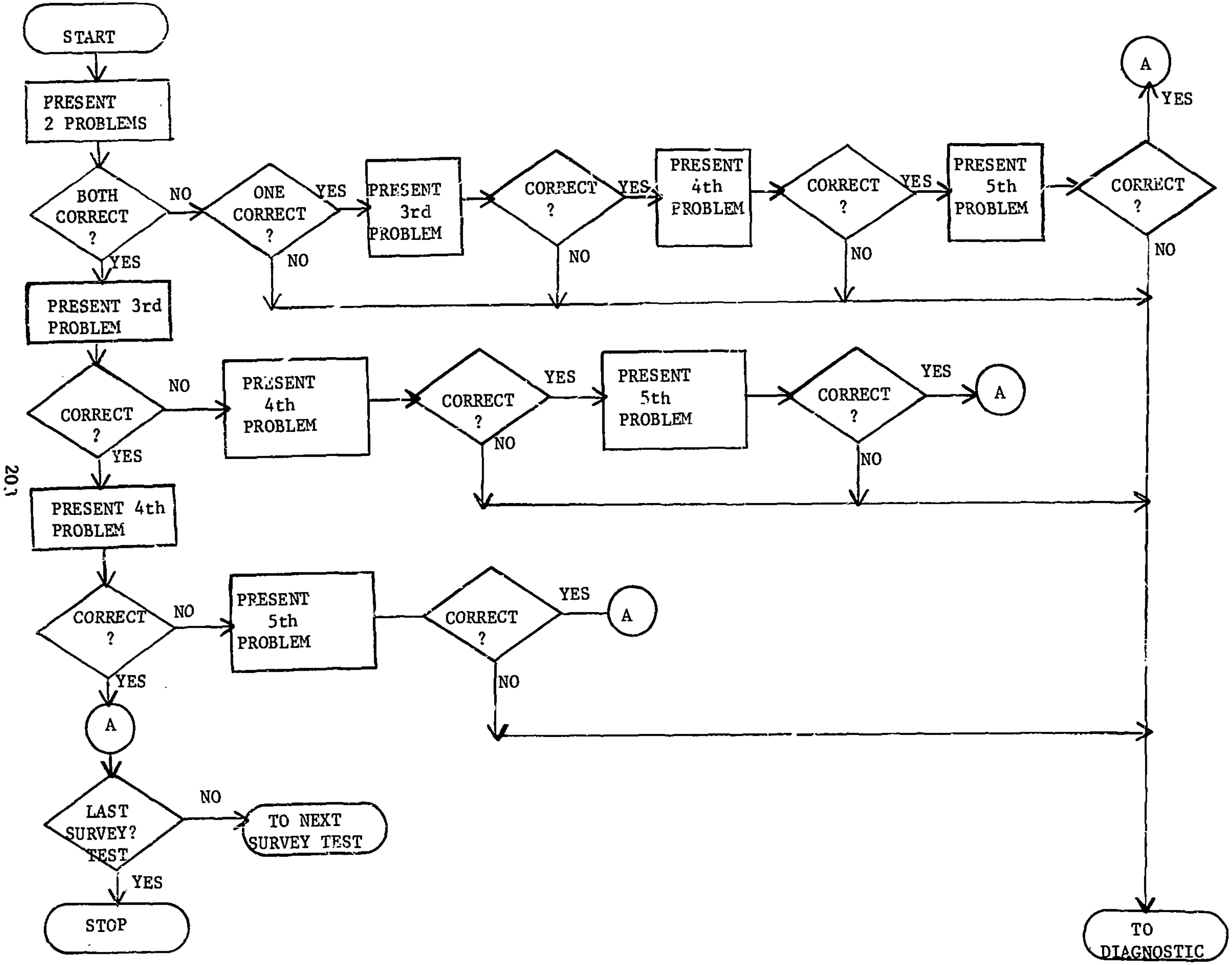

BEGIN
STATEMENT RECEIVED
CHECK BALANCE
AGREE WITH BANK ?
NO
YES
PUT AWAY
3rd TIME?
NO
YES
TAKE RECORDS TO BANK
CHECK DEPOSITS
CHECK CHECKS WRITTEN
CHECK ARITHMETIC
CORRECT ANY ERRORS
STOP

10. GENERAL PLAY OF MONOPOLY TURN


START
TOSS DICE
DOUBLES ?
YES
3rd TIME?
YES
GO TO JAIL
A
NO
NO
MOVE # OF SPACES
PASS GO?
YES
CREDIT PLAYER DEBIT BANK
NO
PROPERTY OWNED ?
YES
DEBIT PLAYER CREDIT OWNER
NO
DOES PLAYER WANT IT ?
YES
DEBIT PLAYER CREDIT BANK
NO
DOUBLES?
YES
NO
A
END OF TURN

11.

SURVEY TEST STRATEGY


START
PRESENT 2 PROBLEMS
BOTH CORRECT ?
NO
YES
ONE CORRECT ?
YES
NO
PRESENT 3rd PROBLEM
CORRECT ?
YES
NO
PRESENT 4th PROBLEM
CORRECT ?
YES
NO
PRESENT 5th PROBLEM
CORRECT ?
YES
NO
A
PRESENT 3rd PROBLEM
CORRECT ?
NO
YES
PRESENT 4th PROBLEM
CORRECT ?
YES
NO
PRESENT 5th PROBLEM
CORRECT ?
YES
NO
A
PRESENT 4th PROBLEM
CORRECT ?
NO
YES
PRESENT 5th PROBLEM
CORRECT ?
YES
NO
A
A
LAST SURVEY? TEST
NO
YES
TO NEXT SURVEY TEST
STOP
TO DIAGNOSTIC

PROGRAMMED INSTRUCTION - - Key to learning activities on pp. 103-125.

1. (1) small steps (2) active responding (3) immediate knowledge of results
(4) self-pacing

2.

37. The "father" of linear programmed instruction in generally agreed to be

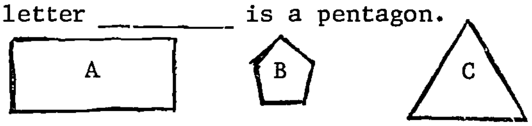
B. F. SKINNER
Go on to next frame.

3. (1) Provides sufficient information to allow student to respond correctly.
(2) Arranges for the student's response - - blank space or multiple-choice.
(3) Supplies the correct or appropriate response and directs the student to the next part of the program.

4. DO
Go to next frame.

5. Circle either A or B.

6. A PENTAGON is a simple closed curve with five sides. The polygon marked with the letter ________ is a pentagon.



If answer is A go to page 13; if B - p. 12; if C - p. 14.

7. Teaching frame -- one or more frames which provide the initial instruction for an objective with the maximum likelihood of eliciting a correct response.

Practice frame -- usually one of a series of frames which require the student to apply or use the new information. Each successive frame normally supplies fewer cues or prompts than the one before (fading).

Criterion frame -- tests the attainment of the objective for a series of frames by providing the minimal stimulus and requiring a response.

8. (1) T (2) P (3) P (4) C

9.

6. The behavior or performance expected at the end of a learning experience is described by ______________________________.
The attainment of the behavior described in an instructional objective is determined by ______________________________.

AN INSTRUCTIONAL OBJECTIVE
A CRITERION TEST

10.

2. If n is an interger and less than 100, then;

(A) 14% = 14 x .01
14 x .01 = ________

(B) 35% = 35 x ________
35 x ________ = ________

(A) .14 (B) .01; .01; .35

3. If n is an integer greater than 100, then;

(A) 110% = 110 x .01
110 x .01 = ________

(B) 525% = 525 x ________
525 x ________ = ________

(A) 1.10 or 1.1 (B) .01; .01; 5.25

4. If n is a decimal numeral, then;

(A) 3.04% = 3.04 x .01
3.04 x .01 = ________

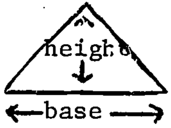
(B) 13.7% = 13.7 x ________
13.7 x ________ = ________

(A) .0304 (B) .01; .01; .137

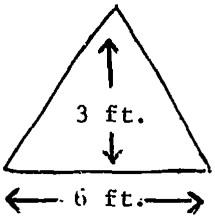
11.

1. To find the Area of a Triangle use the formula:

Area = 1/2 (base x height)



Example:



Area = 1/2 (base x height)
= 1/2 (6' x 3')
= 1/2 (18')

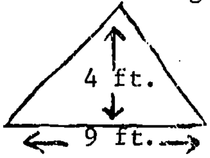
The area is ________.

9 ft.

11. (con't.)

2. Find the area of a triangle with a base of 9 ft. and a height of 4 ft.

Area = 1/2 (9' x 4').
Area = 1/2 (_______).
Area = ________.



36', 18'

---

3. The AREA of a TRIANGLE is found by multiplying 1/2 the _____ times the __________.

base, height

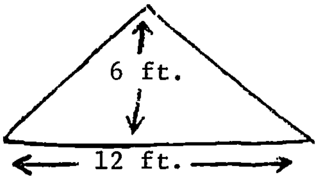
---

4. Area = ____________________.

1/2 (base x height)

---

5. Find the area of this triangle.



The area is __________________.

36 ft.

---

12. Cueing -- a technique for guiding students toward the desired response through the use of various types of hints.

Fading -- gradually withdrawing the amount of cueing until the student can supply the correct response with the minimum stimulus.

13. See pp. 41-47 in Peter Pipe's Practical Programming.

14. Ruleg -- Presentation of a rule (ru) or generalization followed by a specific completed example (eg). This in turn is followed by other incomplete examples which the student completes.

Egrul -- Presentation of several examples before the student is expected to complete the rule.

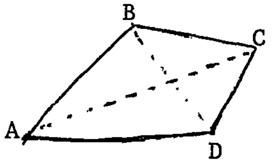
14. con't.

Mathetics -- The completed task is presented initially so the student may see the whole task in its correct form. Then the student is presented the whole task with the last step missing and is required to supply it. Working backward in this manner, the student finally is able to do the entire task.

15. Example A -- Egrul
Example B -- Mathetics
Activity 8 -- Ruleg

16. ____

1. The diagonals of a quadrilateral have been drawn in the figure below by dotted lines.



How many have been drawn? ________

2

2. What line segments in that figure are sides of the quadrilateral?
__________.

$\overline{AB}$, $\overline{BC}$, $\overline{CD}$, $\overline{AD}$ (in any order)

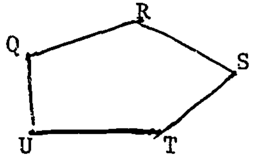
3. What line segments in that figure are diagonals of the quadrilateral?
__________.

$\overline{BD}$, $\overline{AC}$ (in either order)

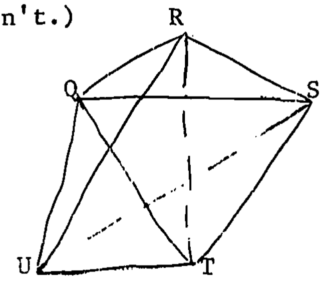
4. Are any of the line segments that are sides, also diagonals?
__________.

NO

5. Diagonals of a polygon are formed by drawing all the line segments connecting the vertices (remember diagonals are not sides). Draw dotted lines to show the diagonals in the pentagon below.



16. 5. (con't.)



6. Is $\overline{QR}$ a diagonal of QRSTU? ______________

No (It is a side; therefore it cannot be a diagonal.)

7. Is $\overline{RT}$ a diagonal of QRSTU? ______________.

Yes (It is a line segment connecting vertices, but not a side of QRSTU.)

8. Line segments connecting vertices that are sides of a polygon (are / are not) diagonals? ________________.

are not

9. Diagonals are __________ ________________ connecting vertices of a polygon, which are not ________ of the polygon.

line segments
sides

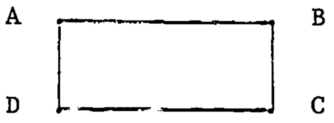
17. (1) Linear programs more often have constructed responses where branching programs depend more on multiple-choice responses.
(2) Typically branching programs present larger segments of information before requiring a response than do linear programs.
(3) All students follow the same path in a linear program where a branching program allows students to follow alternative paths based on their responses.

18. Steps 1 - 7, see Activity 16 answer

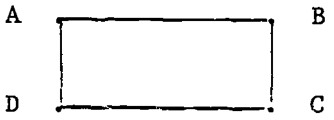
8. Line segment connecting vertices that are sides of a polygon (are/are not) diagonals.

are - go to frame 8a
are not - go to frame 8e

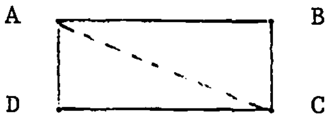
8a Let's review some parts of the program. First, draw a rectangle by connecting the dots A, B, C, D below.



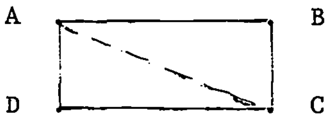
8b This drawing shows four sides of the rectangle.

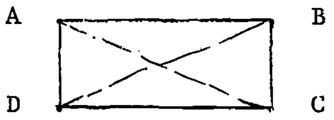


Now draw a dotted line from A to C



8c The dotted line drawn from A to C is a diagonal of rectangle ABCD. Now, draw the dotted line from B to D.





18. (con't.)

8d The two dotted lines you have drawn are diagonals of the rectangle. Line segments connecting vertices of a polygon which (are/are not) sides of the polygon are diagonals.

are not

8e Good, go to frame 9

9 Same as Activity 16

COURSEWRITER II -- Key to activities on pp. 175-182.

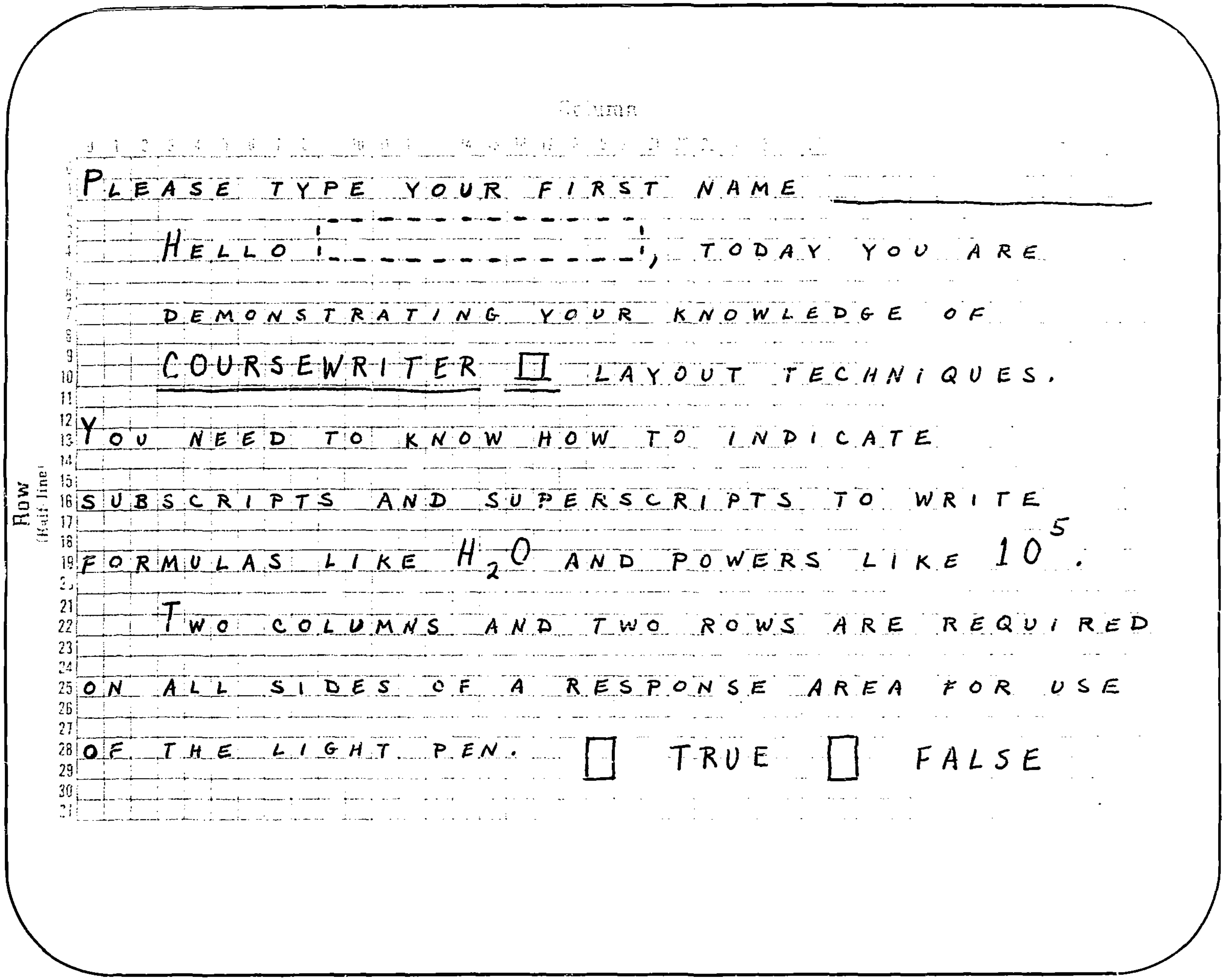
3. See page 5 of the *IBM 1500* Coursewriter II, *Author Guide*.

4. See the "IBM 1500 Programming Reference Card."

7. G 0 7 B ___ ___ A B R ___

↑ ↑ ↗

Reserved for programmer use.


Column
Row
(Half line)

PLEASE TYPE YOUR FIRST NAME ____________

HELLO ¦- - - - - - - - - - - -¦, TODAY YOU ARE

DEMONSTRATING YOUR KNOWLEDGE OF

COURSEWRITER ☐ LAYOUT TECHNIQUES.

YOU NEED TO KNOW HOW TO INDICATE

SUBSCRIPTS AND SUPERSCRIPTS TO WRITE

FORMULAS LIKE H_2O AND POWERS LIKE 10^5.

TWO COLUMNS AND TWO ROWS ARE REQUIRED

ON ALL SIDES OF A RESPONSE AREA FOR USE

OF THE LIGHT PEN. ☐ TRUE ☐ FALSE

T00A - - ABQ -

IN A PROGRAMMED FRAME, THE INFORMATION
OR CLUES THAT HELP A LEARNER
RESPOND IN THE DESIRED MANNER
IS THE STIMULUS.

Display + pause 5 seconds before displaying

THE PORTION OF THE FRAME WHICH
REQUIRES THE LEARNER'S PARTICIPATION
IS CALLED THE ______________.

ca response dt Correct!
wa answer dt STIMULUS → ? Try Again!
un dt Try Again!
If 3rd attempt is incorrect or un, insert RESPONSE and flash 3 times; then
br to next label.

T00A-- ABR-

Column

Row

THE "FATHER" OF LINEAR PROGRAMMED

INSTRUCTION IS GENERALLY

AGREED TO BE:

☐ CROWDER

☐ MAGER

☐ MARKLE

☐ SKINNER

Display responses here. →

P

ca Skinner dt Very Good! br to next label
wa Crowder dt Incorrect. br to #
wb Mager " " "
wb Markle " " "

DEMOBPA3Q4

Column

Row (Half-line)

LOOK AT PAGE 15 IN THE FLIPBOOK.

NOTICE THAT THE FIXED SCALE IS
NOT MOVABLE AND THAT IT CONTAINS
BOTH ENGLISH AND METRIC UNITS.

THE SCALE WHICH DOES MOVE MUST
BE CALLED THE ____________ SCALE.

GOOD REASONING!

ca display

THAT'S A LOGICAL ANSWER, BUT BE MORE
SPECIFIC.

wa - wb display

ca vernier
un insert VERNIER in answer space and flash "VERNIER" and "DOES MOVE" 3 times.
wa movable
wb moveable

A PROGRAMMING LANGUAGE - Key to criterion items on page 198.

1. a. S
   b. V
   c. V
   d. S
   e. V

2. a. 1/5 Reciprocal of 5
   b. 3 Rounds to next lower interger -- if already an interger repeats number
   c. 243 3 exponent 5
   d. 3 Remainder when 3 ÷ 14
   e. -1 Larger of the two numbers
   f. 1 2 3 4 ... 30 Indexes first 30 numbers

3. a. 55
   b. 50 12 9
   c. 4 64 256
   d. 42
   e. 49

4.
```
 )number
 )LOAD
∇A; S
 [1]  'THE AVERAGE OF THE SET OF NUMBER IS'
 [2] +/S÷pS
 [3] ∇

   ) SAVE
   ) OFF
```

5.
```
   ) CLEAR
   ) LOAD
 ∇ A [⎕] ∇

  ∇ A
 [3] 'END OF PROGRAM'
 [4] ∇


 S → 14   97   35   19   27   32
 A
 The average of the set of numbers is 37

 End of Program.
```

APPENDIX F

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