AD-A023 066

LEARNING GUIDELINES AND ALGORITHMS FOR TYPES OF TRAINING OBJECTIVES

James A. Aagard, et al

Training analysis and Evaluation Group (Navy)
Orlando, Florida

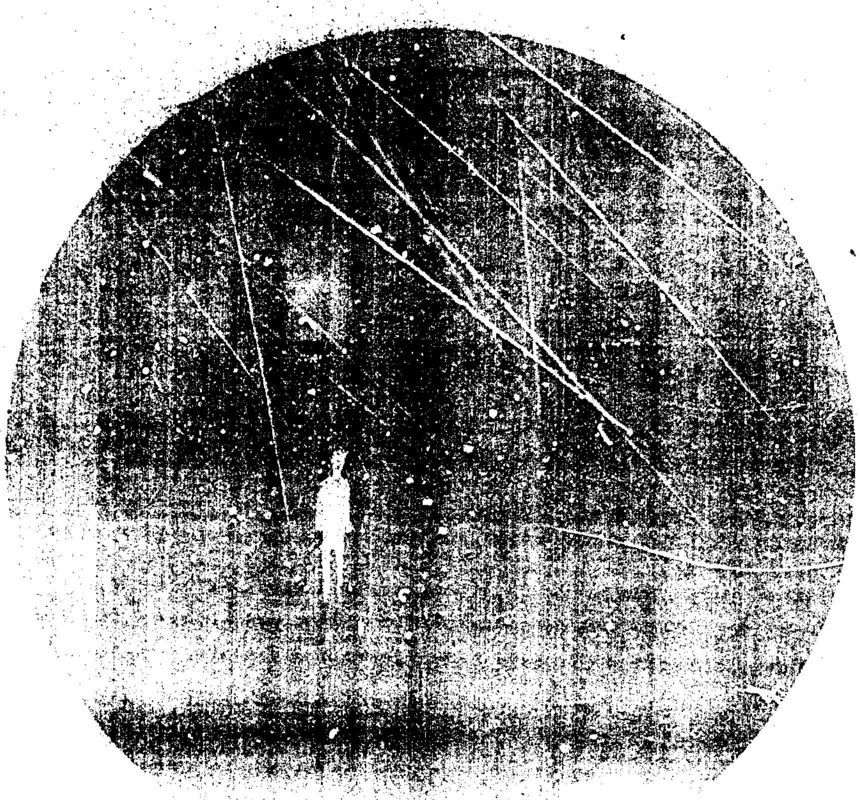
March 1976

TAEG

TRAINING ANALYSIS AND EVALUATION GROUP

TAEG REPORT

LEARNING GUIDELINES AND ALGORITHMS



FOCUS ON THE TRAINED MAN

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TAEG Report No. 23	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LEARNING GUIDELINES AND ALGORITHMS FOR TYPES OF TRAINING OBJECTIVES		5. TYPE OF REPORT & PERIOD COVERED Feb 1974 - Mar 1976 Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) James A. Aagard, Ph.D. and Richard Braby, Ed.D.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Training Analysis and Evaluation Group Orlando, FL 32813		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE March 1976 13. NUMBER OF PAGES 85
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Learning Guidelines
Learning Algorithms
Learning Principles
Classes of Tasks
Instructional System Development

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Training strategies are presented for 11 common classes of training objectives. These classes are: (1) recalling bodies of knowledge, (2) using verbal information, (3) rule learning and using, (4) decision making, (5) detecting, (6) classifying, (7) identifying symbols, (8) voice communicating, (9) recalling procedures and positioning movement, (10) steering and guiding, continuous movement, and (11) performing gross motor skills.

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (continued)

The training strategy for each class of instructional objectives is made up of three parts. The first is a definition of the class and a description of the uniqueness of each class. The second is a set of learning guidelines, consisting of a series of statements which prescribe specific learning elements to be built into the design of a training system. These guidelines are based mostly on learning theory and somewhat on practical experience. They represent information available for prescribing general solutions for a class of training problems. The third part of each strategy is a learning algorithm. The algorithm is expressed as a flow chart of a sequence (or system) of learning events. It represents a logical arrangement of the events called for in the learning guidelines.

These guidelines and algorithms may be used by training system designers as guidance in (1) specifying learning events and activities, (2) selecting instructional delivery vehicles, (3) designing instructional materials, (4) evaluating existing instructional materials, and (5) recording field experience for use in improving the guidelines and algorithms.

TAEG Report No. 23

LEARNING GUIDELINES AND ALGORITHMS FOR TYPES OF TRAINING OBJECTIVES

James A. Aagard, Ph.D.
Richard Braby, Ed.D.

Training Analysis and Evaluation Group

March 1976

ALFRED F. SMODE, Ph.D., Director,
Training Analysis and Evaluation Group

B. G. STONE, CAPT, USN
Assistant Chief of Staff
Research and Program Development
Chief of Naval Education and Training

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

FOREWORD

The guidelines and algorithms of this report are intended to be used by experienced professional training system designers and managers who will be tasked with the planning, design, and utilization of training systems. These professionals should be versed in the psychology of learning and be acquainted with the terminology.

A simplified version of these guidelines has been published separately by the Navy for personnel inexperienced in the application of the psychology of learning. The translation of these guidelines was made by the Center for Educational Technology, Florida State University, and the resulting nontechnical guidelines are presented as a part of NAVEDTRA 106A, the Interservice Procedures for Instructional Systems Development (August 1975).

These guidelines and algorithms are supported by varying amounts of empirical data, but all have at least a basic core of empirical support. The categories of tasks are neither comprehensive nor entirely independent of each other. Finally, it is important that these guidelines and algorithms should be used in conjunction with another report (Braby, Henry, Parrish, and Swope, 1975) which concerns job task categories, training media, and training cost factors to form the widest possible basis for decision making in the design of instructional programs.

ACKNOWLEDGMENTS

The authors wish to thank members of the Center for Educational Technology at Florida State University for encouraging the development of the guidelines and algorithms and for suggestions on simplifying the guidelines. Their suggestions grew out of their editing a draft of these guidelines for incorporation in the Interservice Procedures for Instructional Systems Development. This effort was directed by Robert K. Branson, Gail T. Rayner, J. Lamarr Cox, and Wallace H. Hannum.

Appreciation is also expressed to Gene S. Micheli for valuable suggestions and inputs to this report.

SECTION I

INTRODUCTION

In the process of designing training systems, professionals have been inconsistent in integrating available knowledge and principles on how people learn. Frequently, the translation of psychological learning principles into practices useful for the classroom has not been accomplished, much to the detriment of the instructional program. Since significant training gains can be made through the application of these principles, guidelines which assist the designer in the translation of basic concepts of learning into descriptions of specific action to be taken are needed. To solve this problem, the development of standard guidelines for the structuring of training materials is being seriously examined.

PURPOSE AND USE OF THE REPORT

This report summarizes in a simple, readily usable format, the psychological learning principles applicable to the training of common military job tasks. It provides guidance for training system designers in defining basic learning events which reflect research findings on how people learn specific types of tasks. The use of algorithms (in the form of flow charts) to display learning guidelines in a manner that emphasizes the flow of events and the combining and sequencing of learning guidelines in the design of a training program is also demonstrated.

These learning guidelines and algorithms were used in the development of the Instructional Delivery System Selection Charts in the basic Training Effectiveness, Cost Effectiveness Prediction (TECEP) report (Braby, et al., 1975). As such, this report serves as background information on the TECEP technique and also serves as an aid in carrying out various steps in the TECEP technique.

The learning guidelines and algorithms presented are expressed in nontechnical language. They have been developed from the more formal base of theory so that principles of learning might be more widely understood and used in the design of training systems.

Certain constraints must be considered in the utilization of the guidelines and algorithms. First, these guidelines are general approaches. Their relevance to given training settings must be carefully ascertained. The task categories and related guidelines are not at a level that will accommodate any training setting. In specific instances, it may not be possible to match a given job task with a defined task category. In other instances, it may not be practical to fully implement every learning guideline. In these situations, the training system designer should use the guidelines that do apply to the given training situation.

It should be noted that the algorithms representing the learning guidelines are not the product of empirical research but are the product of rational study. While each of the guidelines can be supported with experimental evidence, the algorithms based on the composite of these guidelines have not been validated; such validation is beyond the scope of the present study. Innovative training methods, based on the guidelines and algorithms, should be tried in pilot studies, evaluated, and modified until they function properly before applying them widely throughout the Naval Training Command.

BACKGROUND

Various attempts have been made to translate specific principles and concepts into general guidelines for training system design. Most have fallen short in that they have not adequately attended to the full range of tasks that occur in military or civilian training programs. These previous efforts have been less than satisfactory for use in the design of military training programs. Several of the more significant efforts, however, are worthy of note and are described next. B. F. Skinner (1954) transformed a series of principles of learning into a set of rules for writing and using programmed texts. By following these rules or guidelines, educators were able to write programmed lessons based on the principles. These rules were subsequently refined (Holland, 1960) as a base of experience accumulated in programmed learning.

Other attempts have been made (Miller, 1957; Sheffield, 1961; Lumsdaine, 1964; Ellis, 1972) to translate specific principles derived from learning theory into guidelines for designing training systems for specific types of learning tasks. A noteworthy effort in this regard was made by Willis and Peterson (1961) in which they analyzed the principles applicable to training of nine major learning theorists and identified a list of learning principles common to them all. Fifty-one guidelines were developed from these common concepts and these were matched with 19 types of Navy training tasks. These sets of guidelines were intended to be used as checklists for the design and use of training devices. However, the guidelines were expressed in language that was too technical and abstract to be useful for most instructional designers and they did not deal with all of the important issues related to the design of learning sequences.

One of the most widely-read attempts to translate learning theory into design guidelines is that of Gagné (1965). Eight types of learning were identified and the conditions of learning for each type described. This work was later refined by Gagné and Briggs (1974) who identified five broad categories of learning outcomes and described the learning principles associated with these types of learning. In both studies, the descriptions of learning were written in the language of the educator and the designer of training programs and not in the technical language of theory. However, Gagne's taxonomy of learning classes cannot be easily applied to the broad range of military job tasks.

A more comprehensive guide is needed to translate learning principles into learning events for military training. The TECEP technique (Braby, et al., 1975) was developed by TAEG to provide the Navy training establishment with learning principles appropriate to Navy job tasks and to outline a method of choosing cost-effective instructional delivery systems that support the use of these learning principles. The TECEP technique incorporates the use of learning guidelines based in part on those used by Willis and Peterson (1961) and by Gagné (1965). Additionally, algorithms were developed to make clear the combining and sequencing of the guidelines. In the TECEP technique (1) common classes of training tasks are defined, (2) a set of learning guidelines and an algorithm are presented for each class of training tasks, (3) some instructional delivery systems capable of carrying out each set of learning guidelines and algorithms are identified, and (4) a cost model is provided for use in projecting the cost of using each instructional design alternative in a specific training setting. Design decisions are based on estimates of both the cost and effectiveness of the various approaches.

ORGANIZATION OF THE REPORT

In addition to this Introduction, two additional sections are presented in this report. Section II presents descriptions of 11 basic types of learning tasks with learning guidelines and an algorithm for each. Directions for the interpretation and use of the algorithms are also presented. Section III contains recommendations for training system designers concerning the application of the concepts presented in the report. A glossary of some technical terms used in the guidelines and algorithms is appended. References are also cited which support the concepts in the learning guidelines.

SECTION II

LEARNING GUIDELINES AND ALGORITHMS

Learning strategies are presented for 11 types of common military training tasks. Each strategy contains (1) a description of the type of job tasks to which the strategy can be applied, (2) learning guidelines (general principles) that will produce the most efficient student learning of these tasks, and (3) an algorithm which combines and sequences the guidelines into a flow of events.

This approach assumes that human learning of specific job tasks can be prescribed using generic classes of learning events and job task categories. By limiting the number of classes to be considered, the process of prescribing solutions is simplified. However, it should be recognized that a high degree of artificiality is inherent in this type of classification scheme. Subtle variations in both job structure and appropriate learning activity are not accommodated. Also skilled performance of a job task usually requires the performer to respond with complex behavior that cuts across the classes in simple classification schemes. Since the guidelines and algorithms presented in this section are basic prescriptions, the training system designer should adapt these solutions into more sensitive responses to the specific requirements of the learning setting.

The guidelines and algorithms can be applied most directly to the early phases of training. After mastering the elemental tasks, the student proceeds to combine different types of elemental tasks into performance segments, phases of a mission, and full mission performance. While individual guidelines are still valid at these higher levels of learning, the application of the algorithms will not necessarily be appropriate. The guidelines and algorithms should be used with these cautions in mind.

Table 1 describes the 11 types of tasks for which learning guidelines and algorithms are provided. By matching the general characteristics of a training objective with the action verbs, behavioral attributes, and examples listed in table 1, the appropriate guidelines and algorithms can usually be identified. Where a clear match cannot be made, a single appropriate TECEP learning strategy may not exist but a combination of several may be required. In these instances the designer may find it necessary to build from the guidelines and algorithms in this report a learning strategy that meets his specific training requirements.

The glossary appended to this report defines the technical terms used in both the learning guidelines and the algorithms. The different kinds of symbols in the algorithms are used as types of instructions. The meaning of each symbol is described in table 2.

TABLE 1. ELEVEN TYPES OF ELEMENTAL LEARNING TASKS

NAMES OF LEARNING TASKS	CHARACTERISTICS OF TRAINING OBJECTIVES WITHIN TASK CATEGORIES		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
1. RECALLING BODIES OF KNOWLEDGE	Answer Define Express Inform Select	1. Concerns verbal or symbolic learning. 2. Concerns acquisition and long-term maintenance of knowledge so that it can be recalled.	1. Recalling equipment nomenclature or functions. 2. Recalling system functions, such as the complex relations between the system's input and output. 3. Recalling physical laws, such as Ohm's law. 4. Recalling specific radio frequencies and other discrete facts.
2. USING VERBAL INFORMATION	Apply Arrange Choose Compare Determine	1. Concerns the practical application of information. 2. Generally follows the initial learning of information through the use of the guidelines for Recalling Bodies of Knowledge. 3. Limited uncertainty of outcome. 4. Usually little thought of other alternatives.	1. Based on academic knowledge, determine which equipment to use for a specific real world task. 2. Based on an academic knowledge of the system, compare alternative modes of operation of a piece of equipment and determine the appropriate mode for a specific real world situation. 3. Based on memorized knowledge of radio frequencies, choose the correct frequency in a specific real world situation.
3. RULE LEARNING AND USING	Choose Conclude Deduce Predict Propose Select Specify	1. Choosing a course of action based on applying known rules. 2. Frequently involves "If...Then" situations. 3. The rules are not questioned, the decision focuses on whether the correct rule is being applied.	1. Applying the "rules of the road." 2. Solving mathematical equations (both choosing correct equation and the mechanics of solving the equation). 3. Carrying out military protocol. 4. Selecting proper fire extinguisher for different type fires. 5. Using correct grammar in novel situation, covered by rules.
4. MAKING DECISIONS	Choose Design Diagnose Develop Evaluate Forecast Formulate Organize Select	1. Choosing a course of action when alternatives are unspecified or unknown. 2. A successful course of action is not readily apparent. 3. The penalties for unsuccessful courses of action are not readily apparent. 4. The relative value of possible decisions must be considered - including possible trade offs. 5. Frequently involves forced decisions made in a short period of time with soft information.	1. Choosing frequencies to search in an ECM search plan. 2. Choosing torpedo settings during a torpedo attack. 3. Assigning weapons based on threat evaluation. 4. Choosing tactics in combat - wide range of options. 5. Choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment. 6. Choosing to abort or commit oneself to land upon reaching the critical point in the glidepath.

TABLE 1. ELEVEN TYPES OF ELEMENTAL LEARNING TASKS (continued)

NAMES OF LEARNING TASKS	CHARACTERISTICS OF TRAINING OBJECTIVES WITHIN TASK CATEGORIES		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
5. DETECTING	Detect Distin-guish Monitor	1. Vigilance - detect a few cues embedded in a large block of time. 2. Low threshold cues; signal to noise ratio may be very low; early awareness of small cues. 3. Scan for a wide range of cues for a given "target" and for different types of "targets."	1. Detecting sonar returns from a submarine target. 2. Visually detecting the periscope of a snorkeling submarine during daytime operations in a sea state of three. 3. Detecting, through a slight change in sound, a bearing starting to burn out in a power generator.
6. CLASSIFY-ING	Identify Recog-nize Differ-entiate Classify	1. Pattern recognition approach of identification - not problem solving. 2. Classification by non-verbal characteristics. 3. Status determination - ready to start. 4. Object to be classified can be viewed from many perspectives or in many forms.	1. Classifying a sonar target as "sub" or "non-sub." 2. Visually classifying a flying aircraft as "friend" or "enemy" or as an "F-4." 3. Determining that an identified noise is a wheel bearing failure, not a water pump failure by rating the quality of the noise - not by the problem solving approach.
7. IDENTIFY-ING SYMBOLS	Identify Read Tran-scribe	1. Involves the recognition of symbols. 2. Symbols to be identified typically are of low meaningfulness to untrained persons. 3. Identification, not interpretation, is emphasized. 4. Involves storing queues of symbolic information and related meanings.	1. Reading electronic symbols on a schematic drawing. 2. Identifying map symbols. 3. Reading and transcribing symbols on a tactical status board. 4. Identifying symbols on a weather map.
8. VOICE COMMUNI-CATING	Advise Answer Communi-cate Converse Direct Express Instruct Interview List Order Report Speak	1. Speaking and listening in specialized terse languages. 2. Often involves the use of a specific message model. Standard vocabulary and format. 3. Also concerns clarity of voice, enunciation, speed. 4. Timing of verbalization is usually critical - when to pass information. 5. Typically characterized by redundancy in terms of information content. 6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns. 7. Task may be difficult due to presence of background noise.	1. Officer giving oral orders and receiving reports. 2. Sonar operator passing oral information over communication net. 3. Instructions by GCA operator to pilot in landing aircraft.

TABLE 1. ELEVEN TYPES OF ELEMENTAL LEARNING TASKS (continued)

NAMES OF LEARNING TASKS	CHARACTERISTICS OF TRAINING OBJECTIVES WITHIN TASK CATEGORIES		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
9. RECALLING PROCEDURES, POSITIONING MOVEMENT	Activate Adjust Align Assemble Calibrate Disassemble Inspect Operate Service	1. Concerns the chaining or sequencing of events. 2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. 3. Procedural check lists are frequently used as job aids.	1. Recalling equipment assembly and disassembly procedures. 2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists). 3. Following equipment turn-on procedures - emphasis on motor behavior.
10. GUIDING AND STEERING, CONTINUOUS MOVEMENT	Control Guide Maneuver Regulate Steer Track	1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc. 2. Compensatory movements based on feedback from displays. 3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol. 4. Involves estimating changes in positions, velocities, accelerations, etc. 5. Involves knowledge of display-control relationships.	1. Submarine bow and stern plane operators maintaining a constant course, or making changes in course or depth. 2. Tank driver following a road. 3. Sonar operator keeping the cursor on a sonar target. 4. Air-to-air gunnery - target tracking. 5. Aircraft piloting such as visually following a ground path. 6. Helmsman holding a course with gyro or magnetic compass.
11. PERFORMING GROSS MOTOR SKILLS	Carry Creep Fall Jump Lift Run Swim Throw	1. Perceptual - motor behavior - emphasis on motor. Premium on manual dexterity, occasionally strength and endurance. 2. Repetitive mechanical skill. 3. Standardized behavior, little room for variation or innovation. 4. Automatic behavior - low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior. 5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate. 6. Fine tolerances.	1. From a kneeling position, throw an M67 fragmentation hand grenade 40 meters on target within effective casualty radius (ECR) using acceptable technique. 2. Wearing a utility jacket, utility trousers, combat boots and armed with M16 rifle, traverse 75 meters in deep water using correct form. 3. Demonstrate the proper technique for a parachute landing fall (PLF) in open terrain. 4. Demonstrate the proper technique of creeping at night across open terrain armed with a rifle. 5. Demonstrate the proper technique of chin-ups starting from 'dead' hang, palms toward face position.

TABLE 2. ALGORITHM SYMBOLS AND MEANINGS

Symbol	Meaning
Decision	A decision or branch point - divides the flow into 2 or more paths.
Information or Direction	Information or directions for program designer or student.
Student Action	Represents student responses, either an answer or movement to a new block in the flow.
Sub-routine	A special sequence of events not presented in the flow, such as a pretest.
Data File	A file of rules, exercises, or student scores; any of these items can be called up as required.
Reference Connector	A technique for connecting the student action lines on two pages of a flow chart (or algorithm).
START or STOP	A symbol for starting a flow or stopping the various paths of that flow.

The 11 learning strategies are presented in the remainder of this section. They appear in the order listed in table 1. Since each strategy is defined in operational terms, it may at times be necessary to refer to table 1 and the glossary for clarification of key words.

A. RECALLING BODIES OF KNOWLEDGE

This category encompasses the learning, recognizing, and recalling of the verbal information needed to function in an operational setting. It includes knowledge of equipment nomenclature, functions, configurations, locations, control inputs, output displays, and the complex relationships between inputs, outputs, and possible equipment malfunctions. Most academic training is of this kind, and therefore students learning these tasks have been readily accessible as subjects for investigators studying the learning and recall of verbal information. The following guidelines are a translation of the findings of this research. The algorithm representing these guidelines is presented in figure 1.

1. Communicate objectives of training to the student at the beginning of the training period.

2. Organize the learning material to meet the stated objectives. Organize training around important cue components (key words, formulas, or phrases) within the body of facts or principles.

3. Provide some warm-up exercises immediately prior to testing for recalling bodies of knowledge.

4. Make learning tasks relevant; i.e., similar to real-life tasks that the student will be performing on the job.

5. Compare directly the names or other data that are similar, or separate their presentation by as much time as possible to avoid confusion.

6. Make sure the students can tell the difference between two or more salient cues that are difficult to distinguish in the operational context before associating each with a response during training.

7. Use mnemonics (association devices) which will cause an affective reaction in the student to aid recall whenever possible.

8. Use mnemonics which will aid in the association of the cue and response terms in the recall of facts or principles. Provide directions for the student to develop his own mnemonics if he can and wants to do

9. Provide for features of the real-world job setting to be used to trigger the student's recall of associated cues which, in turn, will call to mind the knowledge he needs to perform his job.

10. Select attention-getting cues to use throughout the learning events. Select learning activities that require student involvement.

11. Guide (or prompt) the student's response, especially in the early phase of training. Later in training, remove guides to match the level of guides (or prompts) in the operational setting.

12. Arrange for practice of recalling the verbal information by providing retrieval tests very similar to the tests that the student will encounter in the operational setting.

13. Require the student to make an overt response which will show his recall of the facts or principles which, in turn, will enable measurement of his response.

14. Arrange for knowledge of results (KOR) to follow both correct and incorrect responses. Also arrange for positive reinforcement to be interspersed throughout the training following correct recall of facts.

15. Schedule KOR to be presented immediately after a response for maximum effect of KOR.

16. Change the order of presenting facts and principles during practice so that each item in the list of information will be learned equally well.

17. Practice should be distributed (interspersed with rest periods) during training periods especially with (1) the learning of large bodies of facts or (2) complex information. This is particularly useful with slow learners.

18. Individualize instruction to the extent possible. In order for slow learners to reach the same criterion as fast learners, arrange for slow learners to have a higher total number of reinforcements of correct responses than the fast learners.

19. Arrange for the student to compare the program's stated objectives with his status in meeting these objectives (use periodically).

20. Test to determine if the student is able to correctly recall key features of the job setting which serve as cues to him in recalling the knowledge he needs in performing his job.

21. Prevent decay of recall by:

a. Increasing the meaningfulness of the material to be learned (relating it to the student's operational environment) and by relating the organized facts or principles to each other.

b. Requiring the student to overlearn the original material (an essential procedure to reduce forgetting).

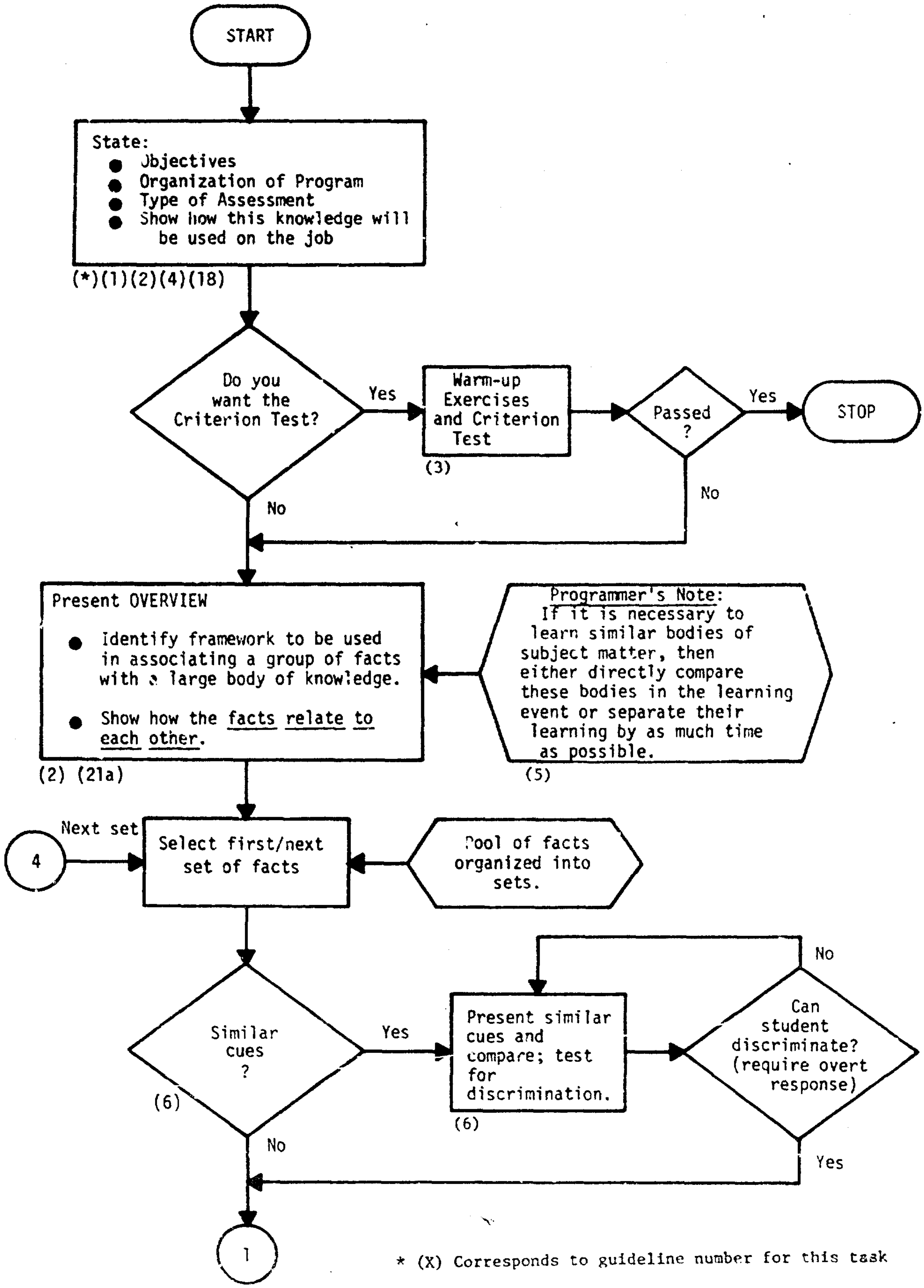


Figure 7. Learning Algorithm for Recalling Bodies of Knowledge

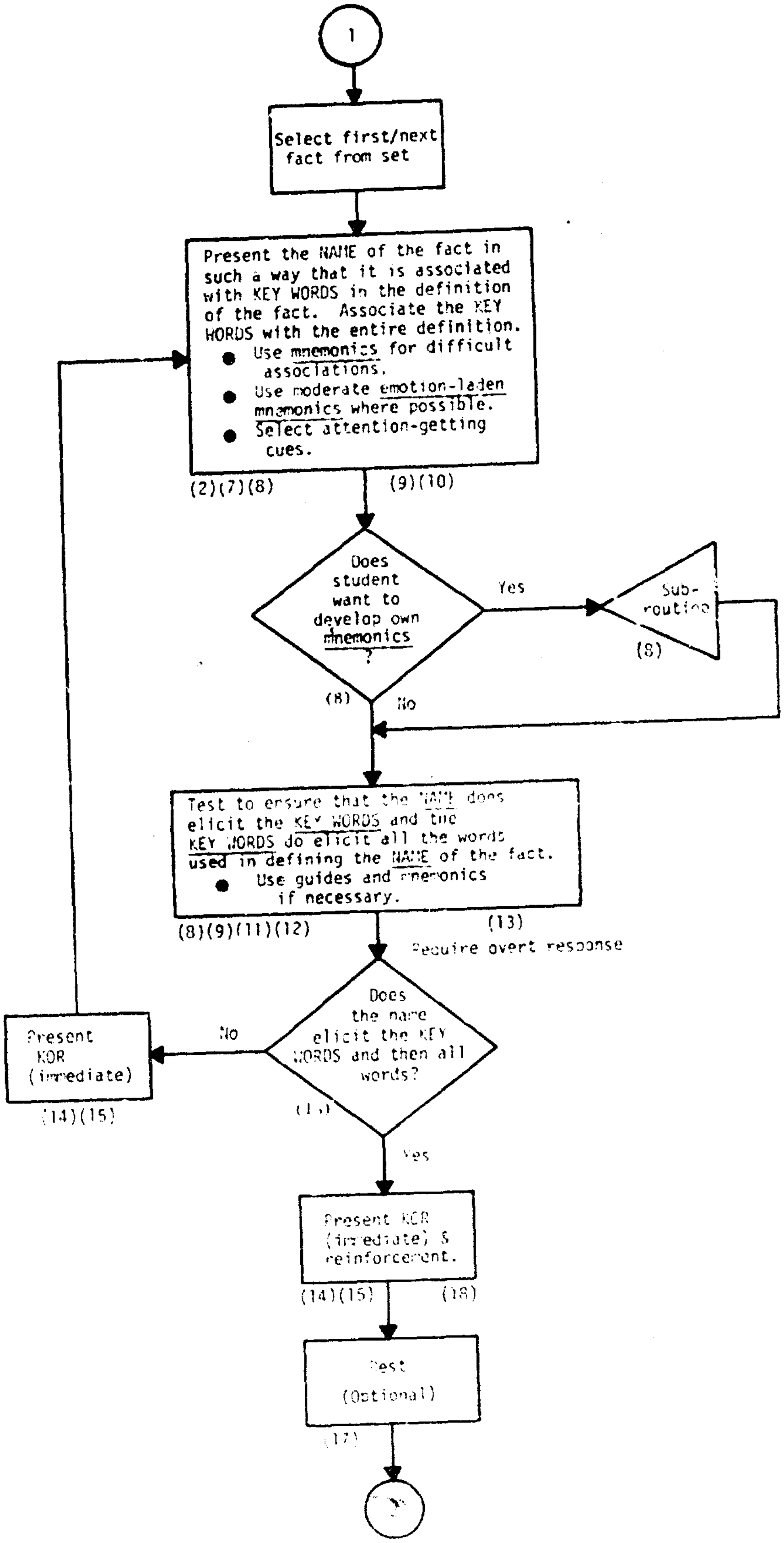


Figure 1. Learning Algorithm for Recalling Bodies of Knowledge (continued)

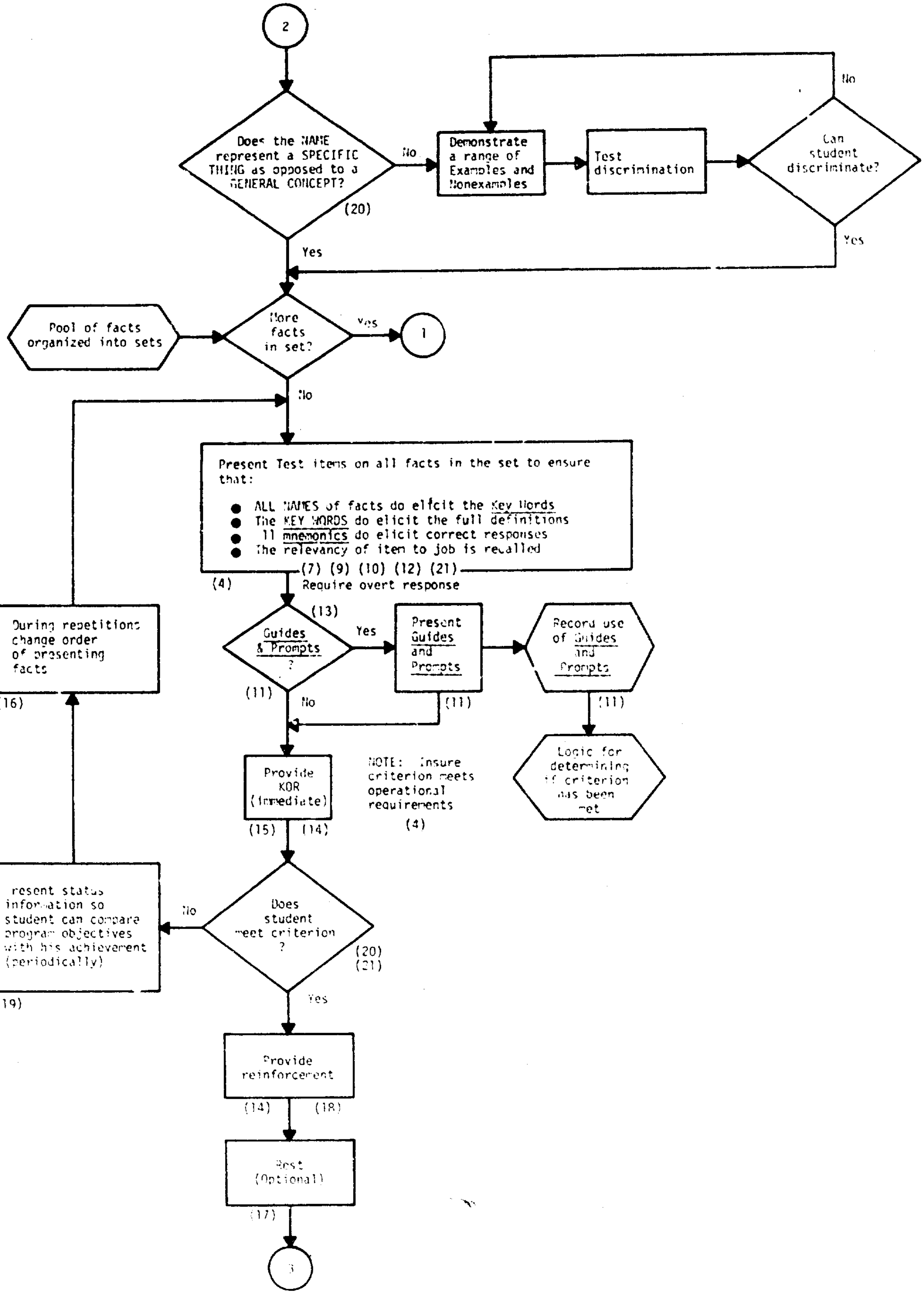
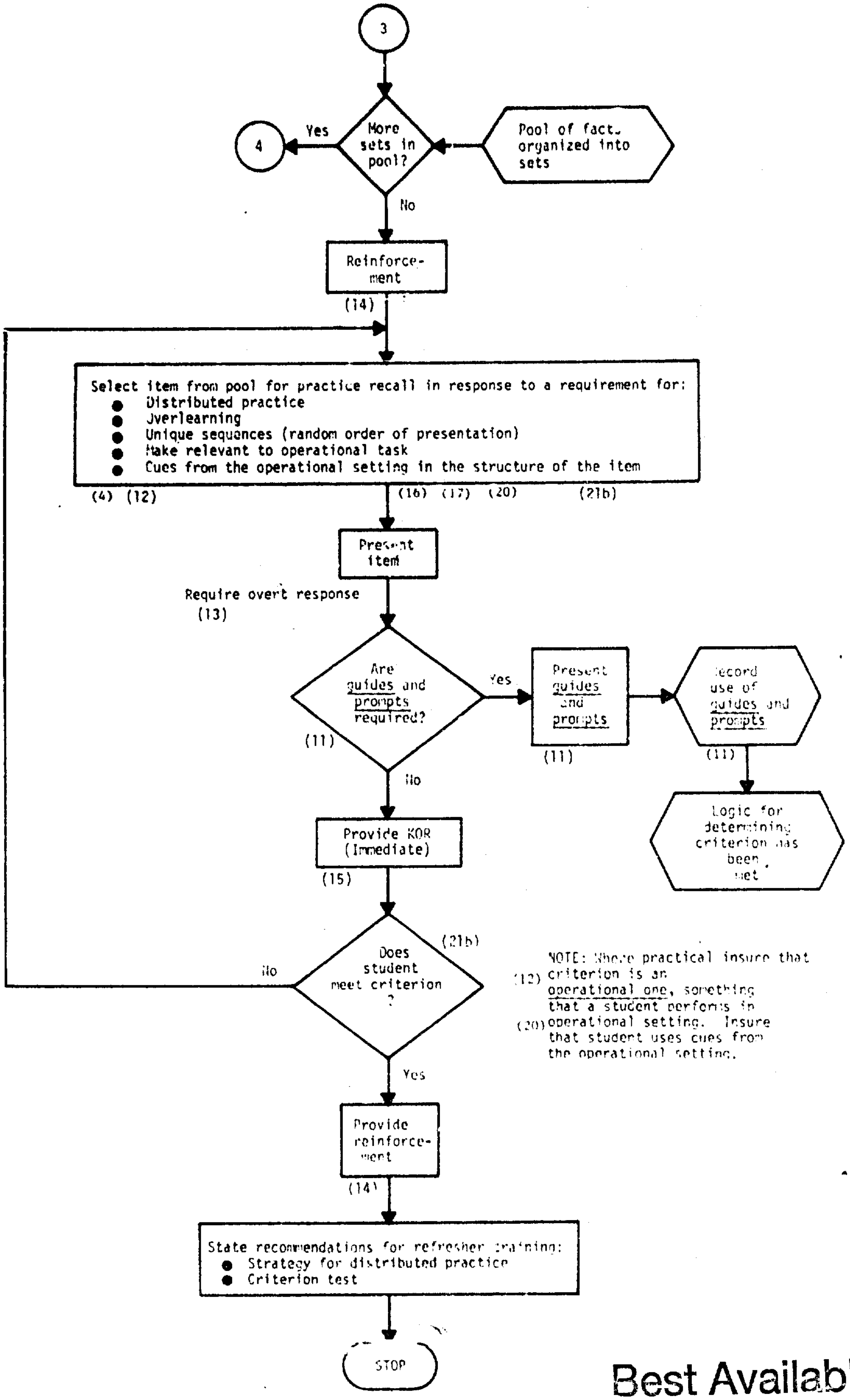


Figure 1. Learning Algorithm for Recalling Bodies of Knowledge (continued)



Best Available Copy

Figure 1. Learning Algorithm for Recalling Bodies of Knowledge (continued)

B. USING VERBAL INFORMATION

This task category involves recalling and applying previously learned facts and principles as needed in a job setting. It is a component of most jobs. In the guidelines for this task category, attention is focused on increasing the transfer of learning from the classroom to the job. An example of using verbal information is that of a radar operator faced with a tactical situation where a change in antenna search mode might increase the probability of the detection of an expected target. The operator recalls the various modes and their characteristics and then chooses an appropriate mode. This involves the application of principles and concepts, not the application of a fixed decision procedure.

The amount of empirical data which supports the guidelines for the task category is meager. Not much research has been accomplished on the application of knowledge in the operational setting. Traditionally, the emphasis has been on acquiring knowledge in the classroom with the assumption that if one has previously learned the knowledge he can easily recall and apply it when required to do so on the job. But this assumption is not always warranted. Students have considerable difficulty applying in the operational setting that which they learn in a rote fashion.

The following guidelines apply to using verbal information. The algorithm representing these guidelines is presented in figure 2.

1. Insure that previously learned verbal information is organized into generalizations, unifying concepts, and principles to promote transfer as the first step in training how to use verbal information.

2. Give the learner practice in applying the generalizations and unifying concepts to tasks similar to those in the operational setting that he will be encountering.

3. Provide knowledge of results as soon as the learner has made his application; provide reinforcement for his correct applications.

4. Require that practice in applying the principles covers the wide variety of operational situations that the student will be presented with on the job.

5. Provide examples of applications of more abstract principles or generalizations that have been shown to be difficult to apply to the operational setting.

6. Reinforce the student when he makes practical applications of verbal information.

7. Ensure practice until the student achieves job entry level of skill.

8. Vary both the context of salient cues and the principles to be applied during practice.

9. Provide for refresher training when there has been extended absence from the task or where such training is indicated by performance on the job.

10. Give job sample tests ("dry runs") in the operational setting occasionally to determine need for refresher training, where this is practical to carry out.

11. Provide for individual training at student's own rate.

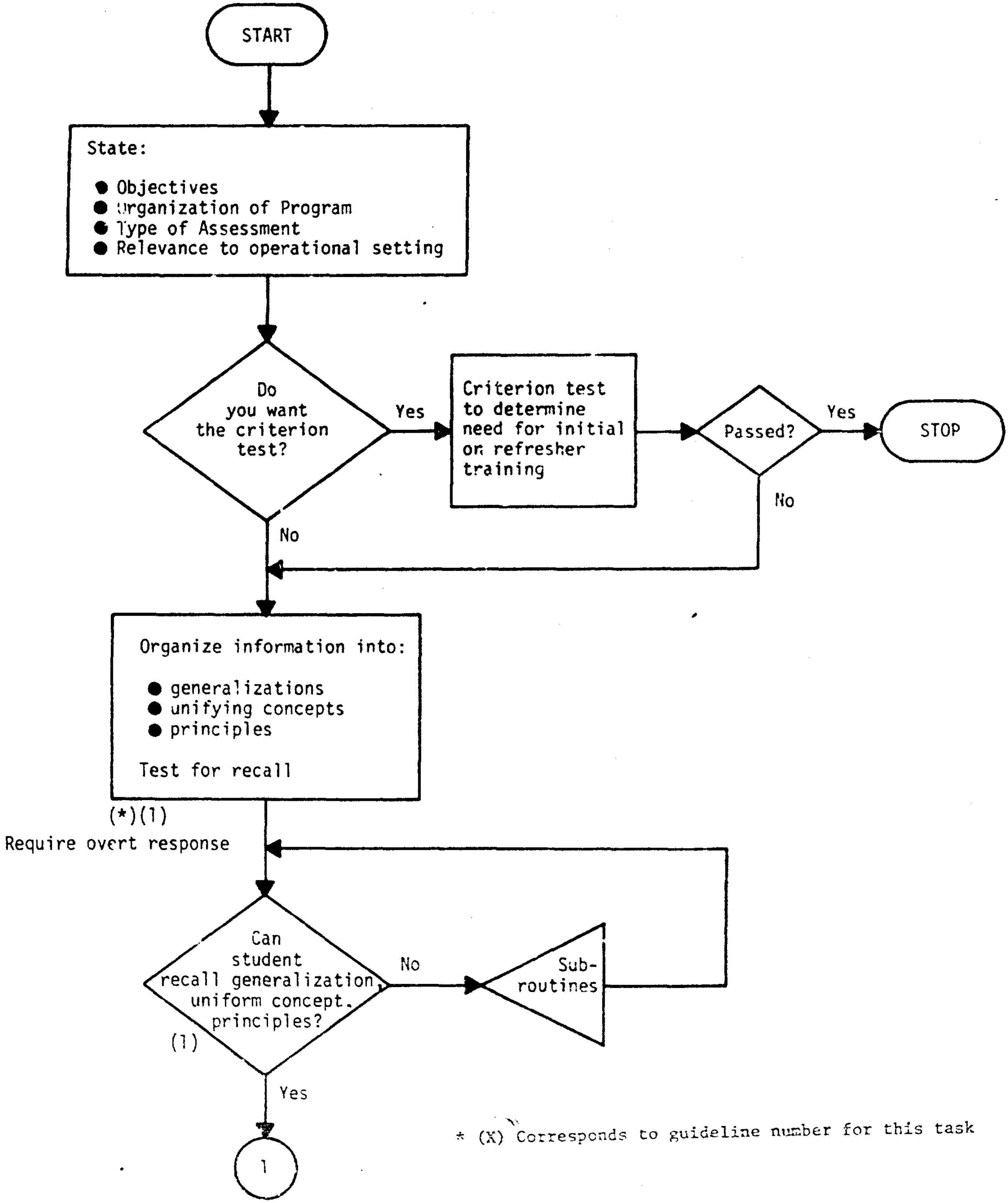


Figure 2. Learning Algorithm for Using Verbal Information

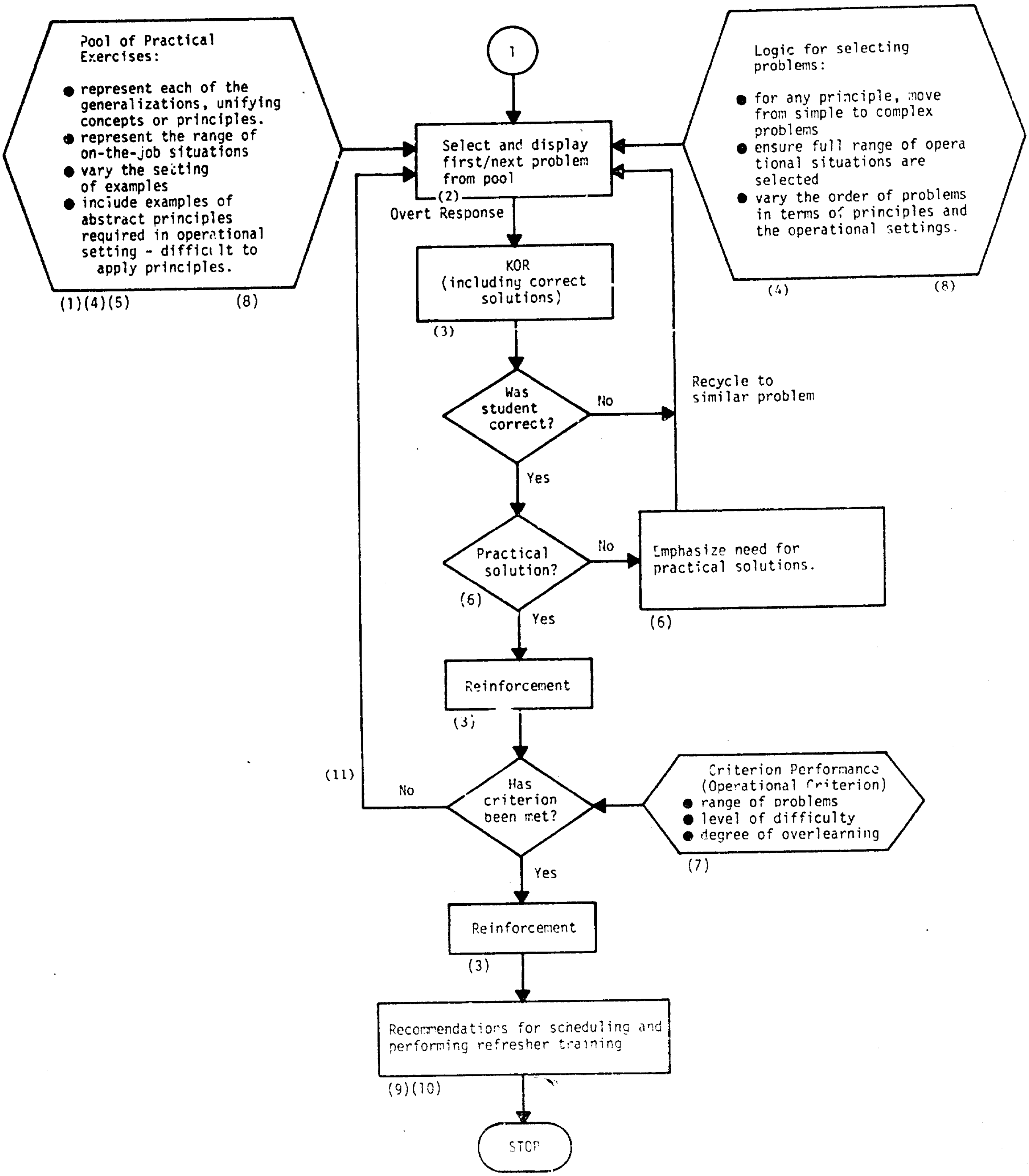


Figure 2. Learning Algorithm for Using Verbal Information (continued)

C. RULE LEARNING AND USING

This category of job task concerns the acquisition and application of established practices or fixed principles (rules) that serve as guides in selecting courses of action. These rules may be based on current practices or on a knowledge of what normally happens in similar job situations. Rules are frequently expressed as "if-then" statements or directives not to be questioned by the user. The user merely concerns himself with whether the proper rule has been selected and is being applied correctly. There are many examples of rules that must be learned and used. Typical examples include using rules-of-the-road in guiding a ship through inland waterways, solving mathematical problems using the rules for manipulating numbers, using correct protocol in displaying the flag in a formal ceremony, applying grammar rules in writing a sentence, and writing a computer program according to the rules of a specific programming language. Although rules are commonly used in selecting courses of action, limited research has been performed on learning to apply rules. The learning guidelines are based on the available research and general learning principles, where appropriate.

Guidelines for rule learning and using are listed below. The algorithm representing these guidelines is presented in figure 3.

1. Insure that the individual words which comprise the rule are understood before proceeding to rule learning.

2. Require that the student state the rule verbally. This verbal statement of the rule serves to cue the recall of the concepts that make up the rule and their arrangement within the rule (this usually should be an informal statement of the rule).

3. Present examples showing when the rule applies and when it does not.

4. Use mnemonics (where possible) in the learning of difficult to recall rules and the application of these rules. Use cues from the operational setting in the mnemonics to facilitate the recall of the mnemonics.

5. Give the learner an opportunity to apply the rule in new situations and give knowledge of results following each application. Provide reinforcement for correct applications of the rule.

6. Test the learner by requiring him to state the relationships among the concepts in new situations to insure that he understands the rule.

7. Provide practice in applying the rules until the student achieves some stated criterion performance; i.e., until he learns the rules and

learns to apply the rules across the range of situations he will find in the operational job setting.

8. Reduce the frequency of reinforcement of correct applications at the end of training to a level that exists in his job setting.

9. Relate the rules to be learned to the operational job setting in order to provide motivation for rule learning.

10. Provide for (1) individualized learning to allow for individual differences in learning and (2) periodic refresher training when the student has had an extended absence from performing the job.

11. Guide the student to discover a useful rule by having him respond to a sequence of leading questions, if the student is having a difficult time understanding and applying a rule.

12. Arrange for slow learners to have a higher total number of reinforcements of correct responses than the fast learners.

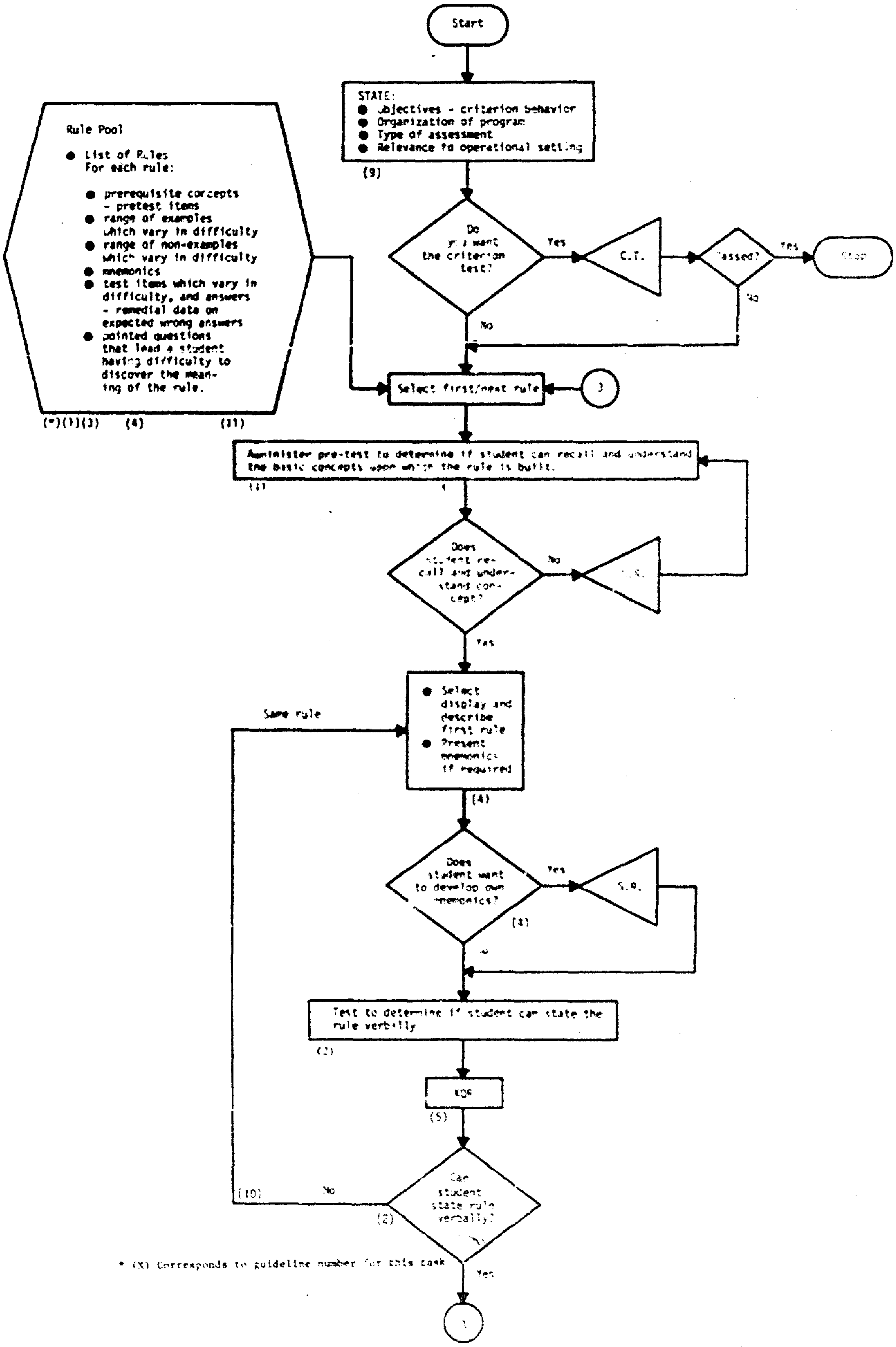


Figure 3. Learning Algorithm for Rule Learning and Using

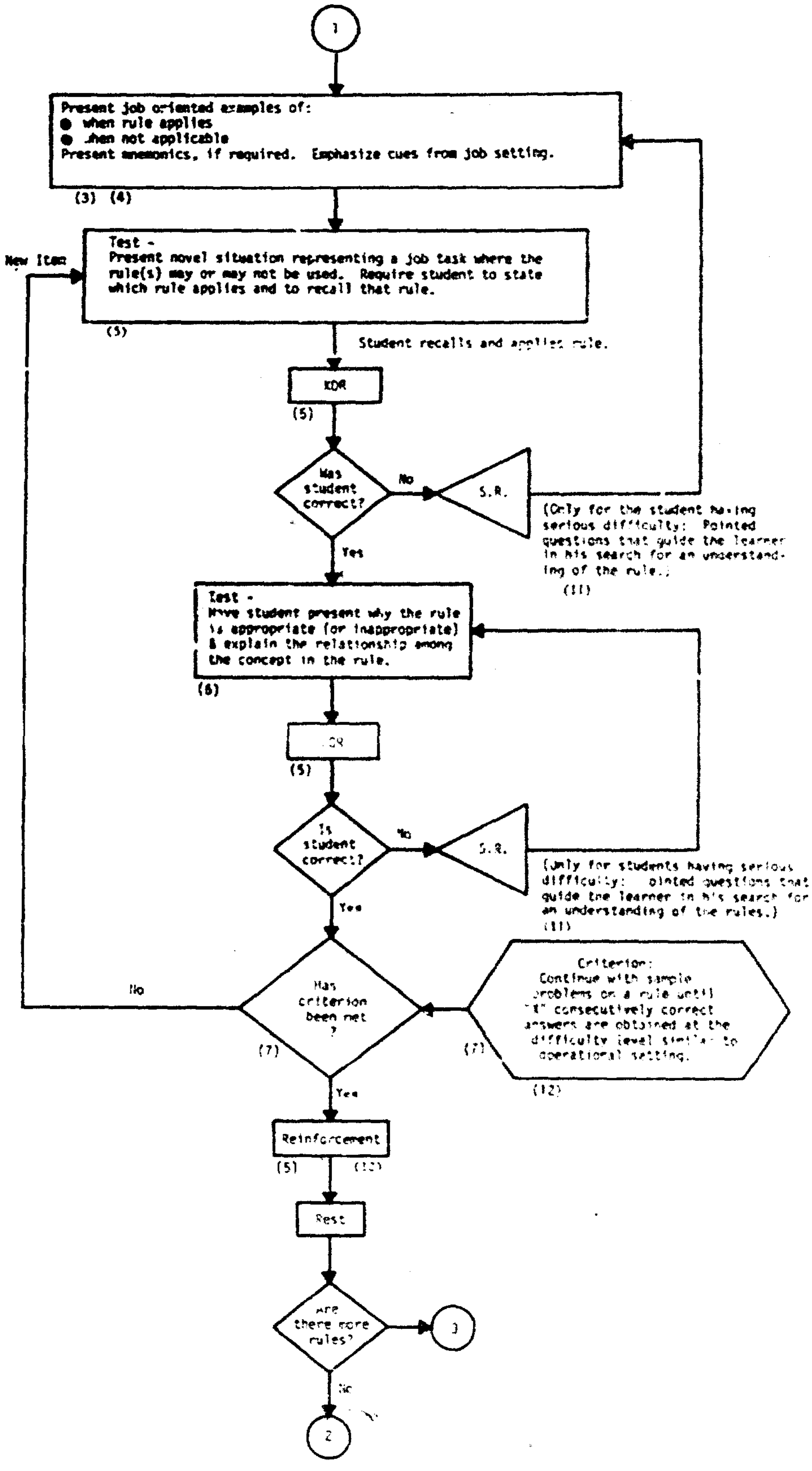


Figure 3. Learning Algorithm for Rule Learning and Using (continued)

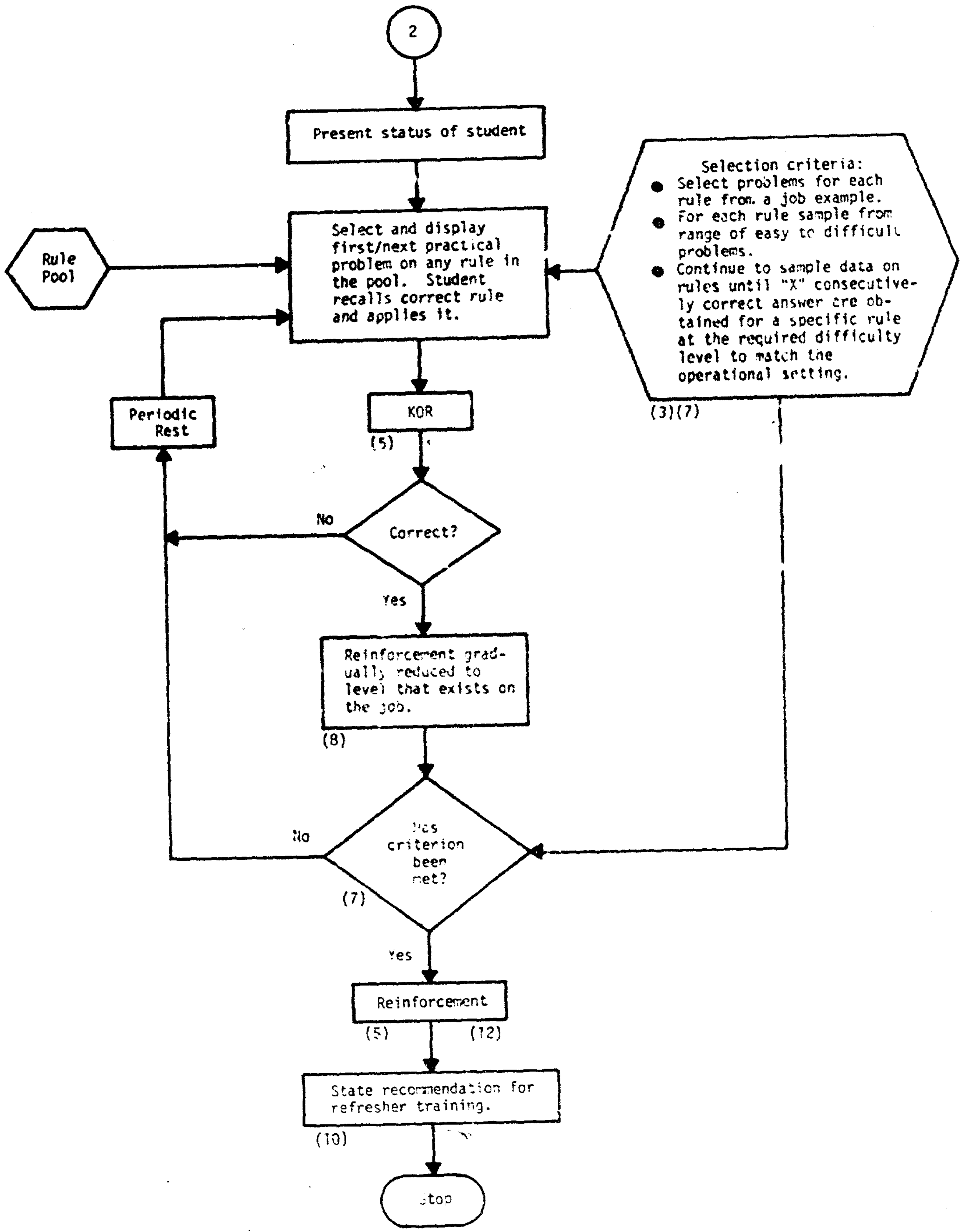


Figure 3. Learning Algorithm for Rule Learning and Using (continued)

D. MAKING DECISIONS

Decision making is defined here as the application of a specific decision model, thought to be useful in diagnosing equipment malfunctions, choosing tactics in Fleet operations, and in planning where several alternatives must be considered, each with an unknown probability of success. The decision model combines the following factors: perception of the problem, identification of alternative solutions, evaluation of these alternatives and selection of the apparent best solutions. Therefore, the guidelines and algorithm presented here support learning to use this decision model.

The decision-making guidelines presented here are based upon the most fashionable practices in existing decision-making training programs.

The following guidelines apply to decision making training. The algorithm representing these guidelines is presented in figure 4.

1. Ensure that the student acquires the knowledge required to:

    a. identify the problem,

    b. generate reasonable solutions,

    c. evaluate these solutions.

2. Decrease student anxiety to a low level, particularly in the early stages of training, where student anxiety is high and where complex decisions are to be made.

3. Give the student examples of these two types of actions which are to be avoided when making a decision:

    a. The tendency to make a "favorite" decision or use a "favorite" solution regardless of the real nature of the problem.

    b. The tendency to generalize problems or view several types of problems as if they were all the same when, in fact, they are quite different.

Give examples of these undesirable responses in decision making.

4. Teach a decision-making strategy; the following strategy is suggested:

    a. Upon becoming aware of the problem, define it.

    b. Be alert for the availability of relevant information and collect such data.

c. Develop alternative solutions.

(1) State alternative solutions,

(2) Combine alternative solutions,

(3) Compare alternative solutions.

d. Evaluate alternative solutions.

(1) List the probable consequences of each alternative solution,

(2) Rank each alternative solution according to desirability of consequences.

e. Choose course of action based on a desired solution.

f. Execute the chosen course of action.

5. Vary the setting of the significant cues of the decision-making learning task. Provide both basic and advanced problems to be solved with a wide range of problem difficulty at each level of training for the operational tasks.

6. Insure the overlearning of decision-making skills in later stages of training if the student will be required to perform under stress in the real world.

7. Present the student with a realistic data load (i.e., realistic amount of significant data) plus operational distractors in real time toward the end of training.

8. Provide the student with access to potentially relevant data during practice. In the final stage of training, the data available to him should be limited to that expected in the real world situations in which he will be working.

9. Provide the student with answers to the five following questions after his decisions in practice problems. These answers serve as knowledge of results (KOR).

a. Predictability? (Were problems mistakenly viewed as if they were all the same in reaching solutions?)

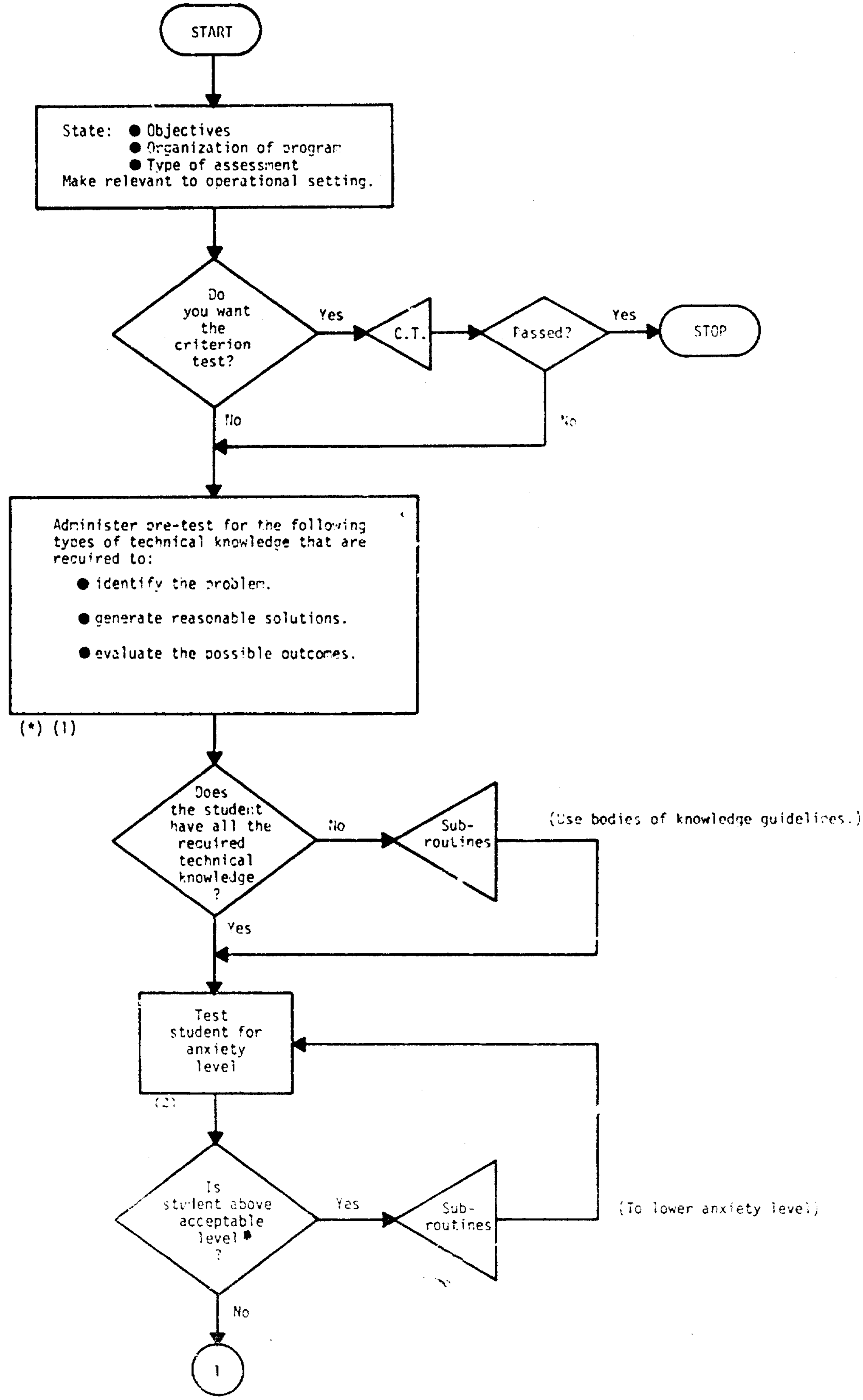
b. Persistence? (Was use made of a "favorite" solution when it was inappropriate?)

c. Timeliness? (Was this the appropriate time to execute this particular decision?)

d. Completeness? (Was all of the available information considered?)

e. Consistency? (Was the solution compatible and relevant to the available information?)

Give KOR with respect to the above five criteria each time the student makes a decision and, if possible, provide the simulated consequences of the decision as compared to alternative solutions.



* (X) Corresponds to guideline number for this task

Figure 4. Learning Algorithm for Making Decisions

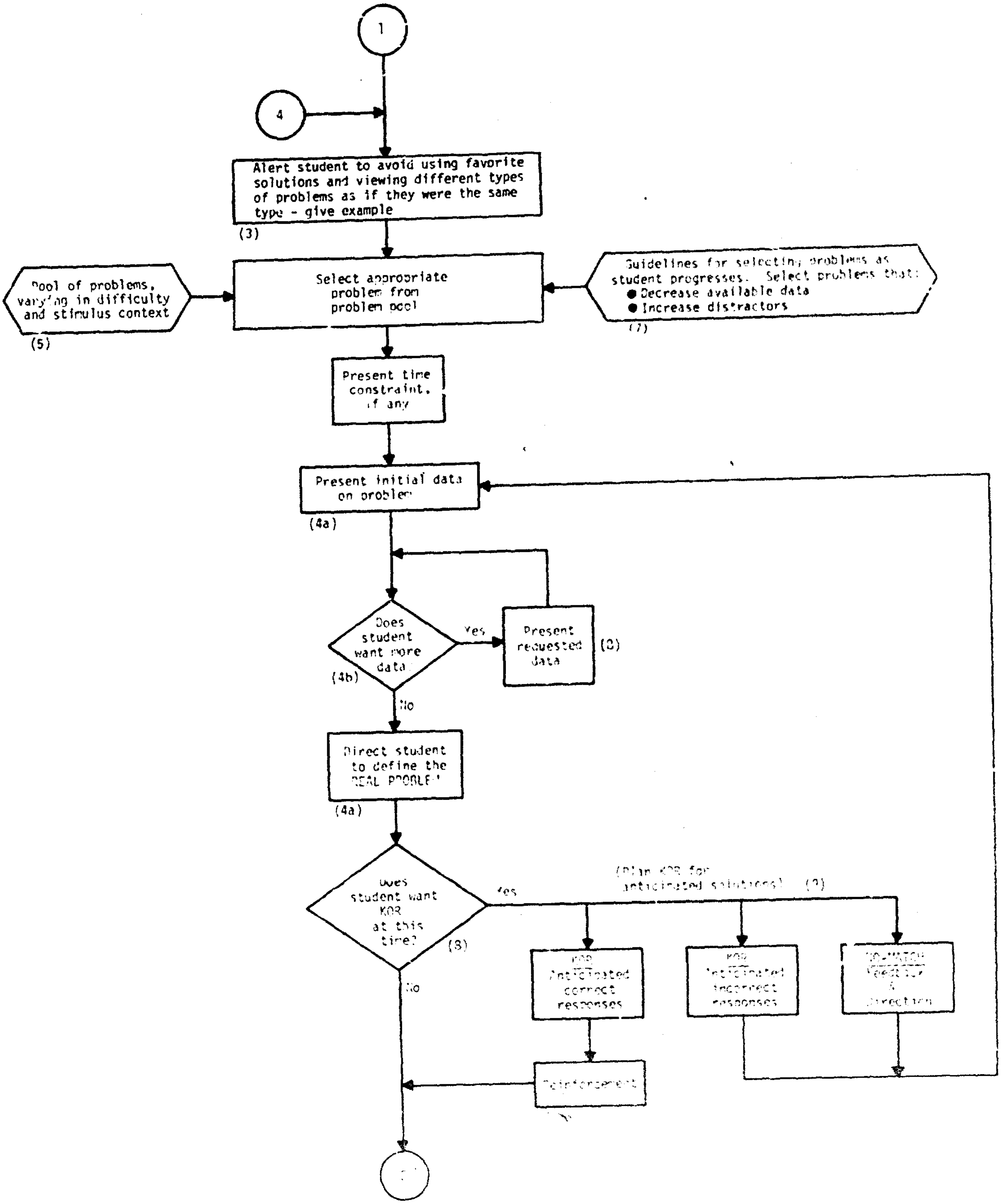


Figure 4. Learning Algorithm for Making Decisions (continued)

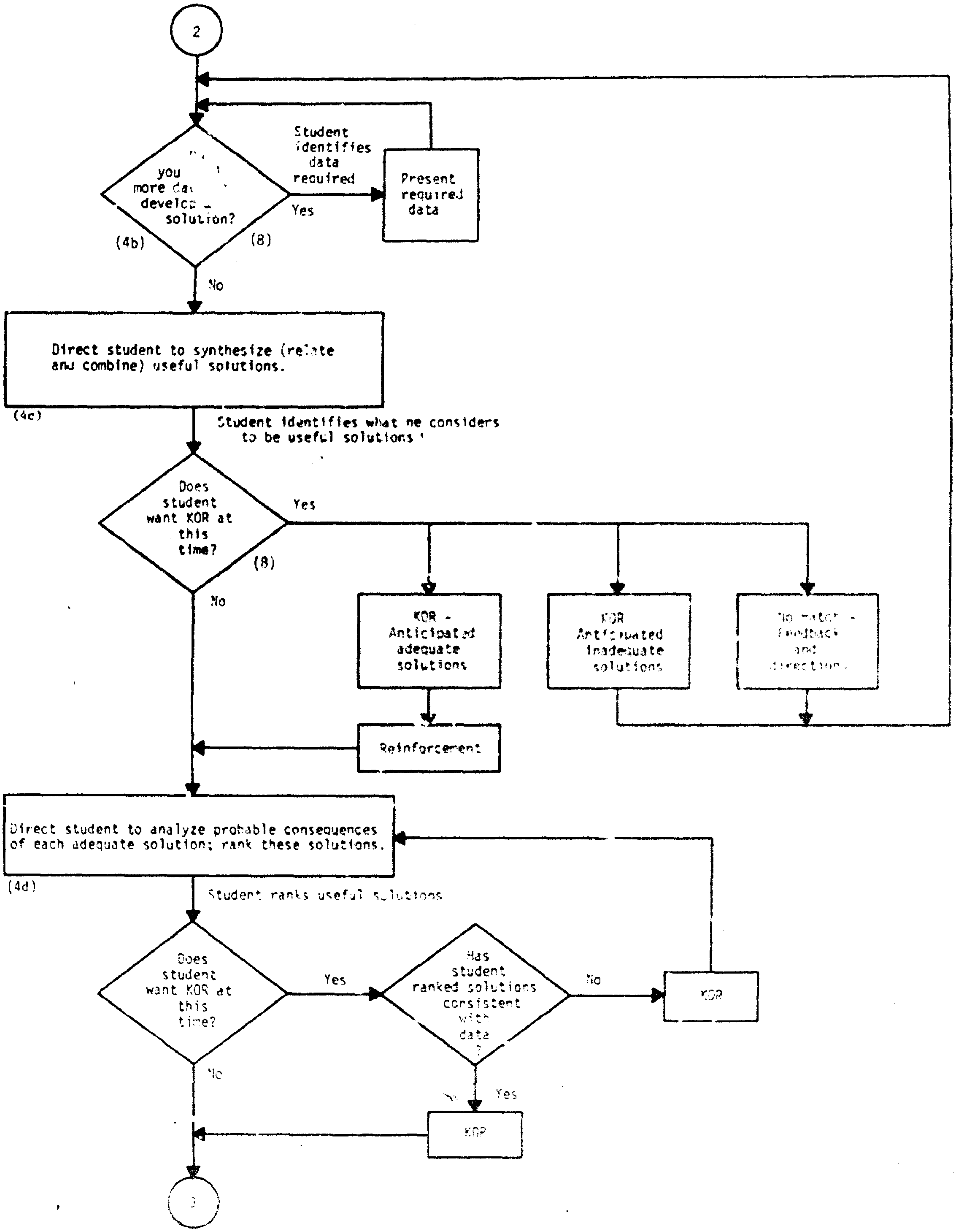


Figure 4. Learning Algorithm for Making Decisions (continued)

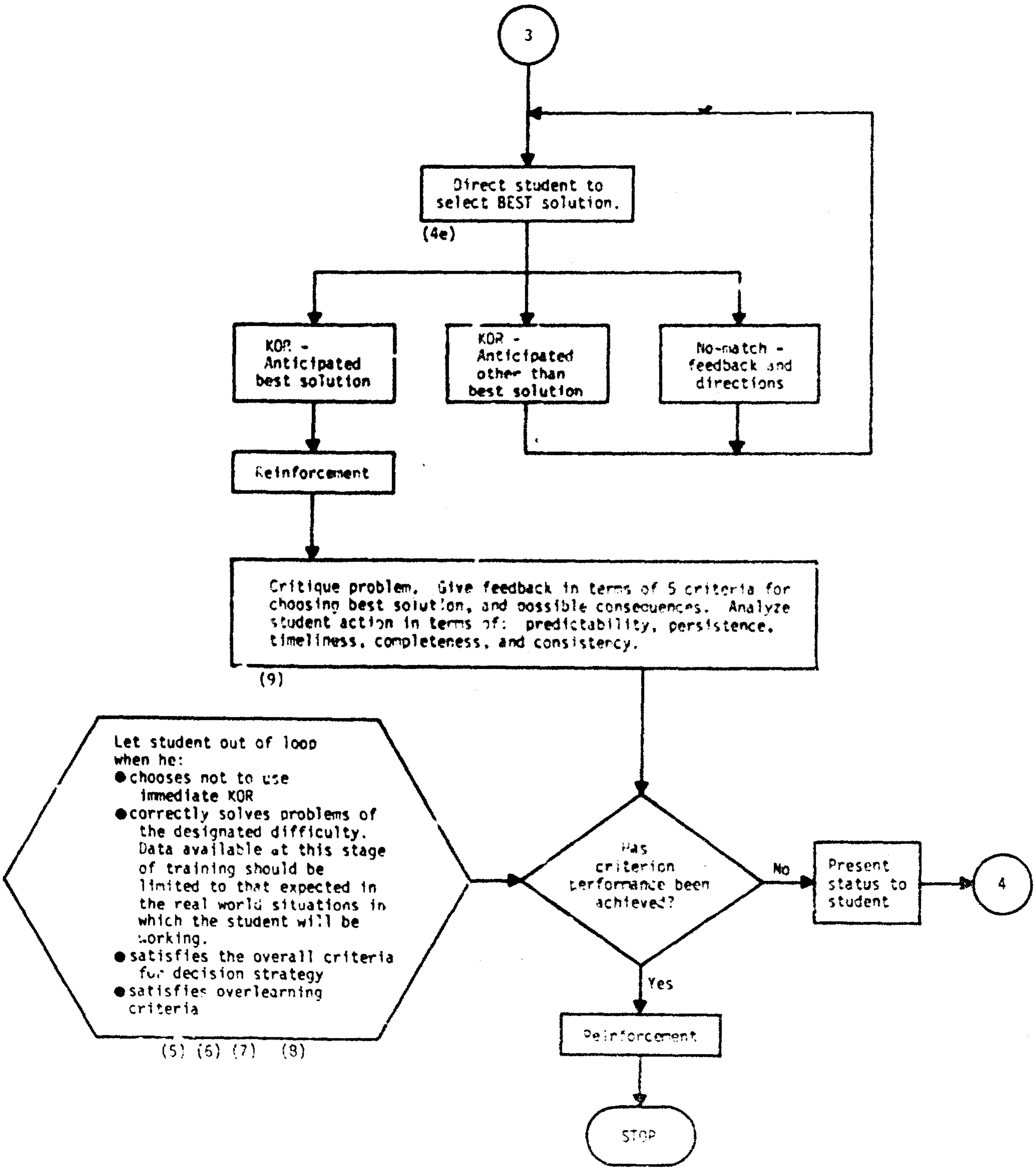


Figure 4. Learning Algorithm for Making Decisions (continued)

E. DETECTING

This task concerns the act of becoming alert to the presence of a signal that could be of special interest in the performance of a job or mission. Detecting is essentially a matter of becoming aware of certain cues, including those almost hidden in distracting backgrounds, and it stops short of verifying the nature of the signals. In many practical situations after a signal is detected it is immediately classified. The early detection of targets is usually a significant part of any tactical task. Examples include an operator becoming alert to the presence of targets on a radar or sonar display, a mechanic becoming alert to slight changes in the functioning of a piece of equipment signaling an emerging malfunction, and a pilot visually scanning through the window of his aircraft and spotting another aircraft sharing his airspace. In these detection tasks, involving long periods of time between the appearance of significant signals, maintaining vigilance is an important part of performance.

The following guidelines apply to detecting. The algorithm representing these guidelines is presented in figure 5.

1. Train the student to use systematic overall search procedures utilizing his appropriate senses. Use models of correct behavior, where needed.

2. Present signals from the full range of types of signals. Include the various signal sources that the student will encounter on the job and the different patterns of each signal source.

3. Train the student to use techniques of vigilance to:

a. establish a mental set to search. Use instructions to establish this set and reinforce the student when he achieves a proper set.

b. constantly monitor internal biological cues in order to determine own vigilance level (state of alertness).

c. use, where appropriate, peripheral vision in scanning; i.e., to rely on detections made from the side of direct line of sight.

4. Train the student in detection skills according to the following schedule:

a. Early in training use:

(1) high signal density - more frequent than in the operational task,

(2) signals that have a high signal-to-noise ratio,

(3) different amounts of time between signal presentations,

(4) high response rate from the learner,

(5) immediate and continuous knowledge of results (KOR),

(6) reward for responding to any real signal.

b. During the intermediate stage of training use:

(1) a lower signal density,

(2) lower signal-to-noise ratios,

(3) different amounts of time between signal presentations,

(4) KOR on an intermittent time schedule,

(5) specific vigilance techniques; i.e., mental set to search and monitor internal cues to state of alertness.

(6) intermittent reward for responding to real signals,

c. In advanced state of training use:

(1) low signal density; i.e., operational density or minimum number suited to training program,

(2) a signal-to-noise ratio comparable to the operational level,

(3) signals presented within different time intervals,

(4) KOR on a schedule equivalent to that found in the job setting (describe realistic consequences for signals missed),

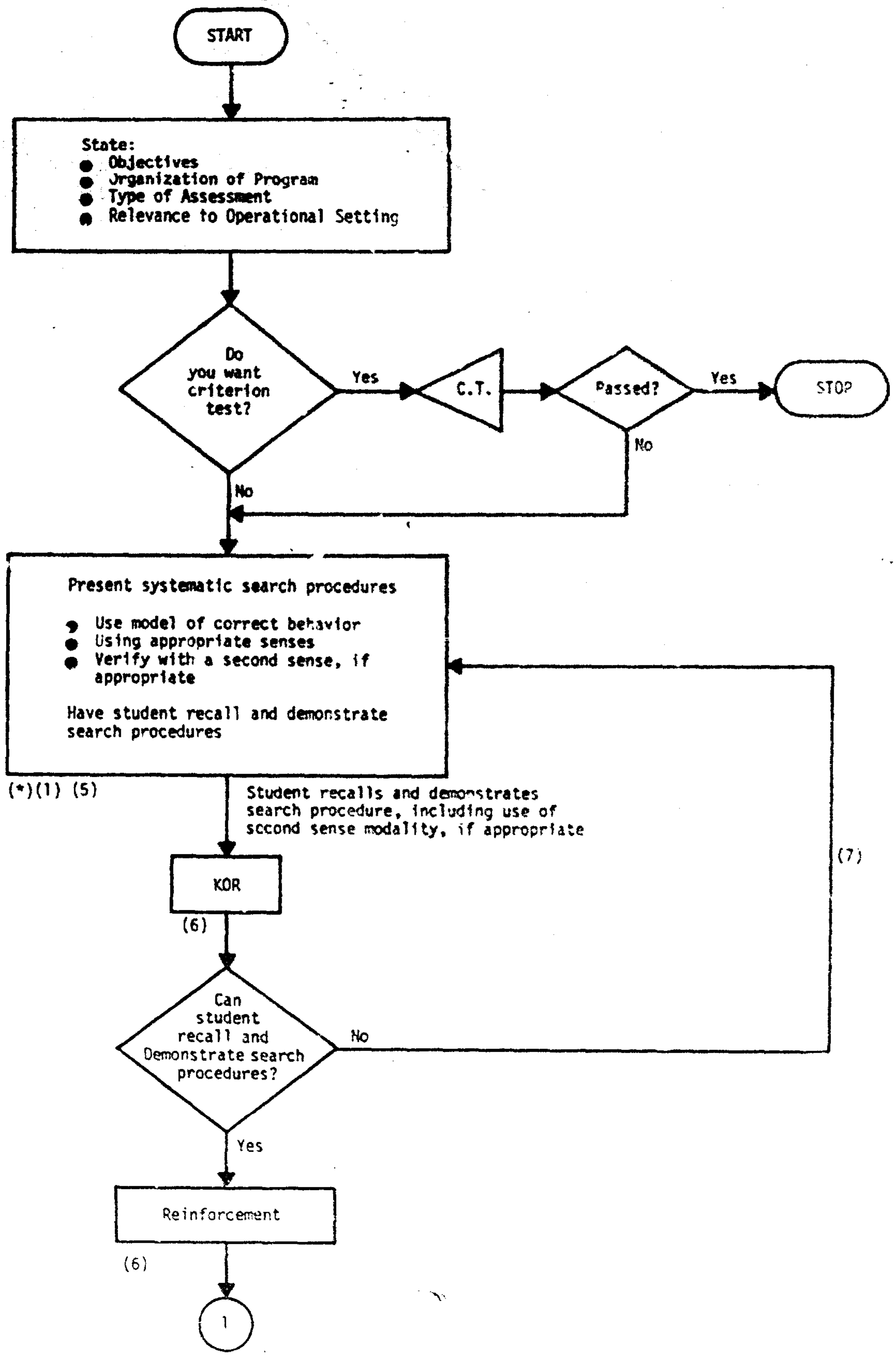
(5) vigilance techniques which are appropriate to the job setting,

(6) operational level of reward following correct detection.

5. Train the student to use a cue detected by one sense (such as hearing) as a stimulus to search for and detect the existence of a related cue in a second sense (such as sight) where it is possible to detect a target by more than one sense.

6. Present the student with his status; i.e., progress towards meeting the training program objectives. Reward him for progress toward these goals.

7. Individualize training. Keep student practicing at each phase (or level) of the learning task until the required level (or mastery) of the job performance is achieved.



* (X) Corresponds to guideline number for this task

Figure 5.- Learning Algorithm for Detecting

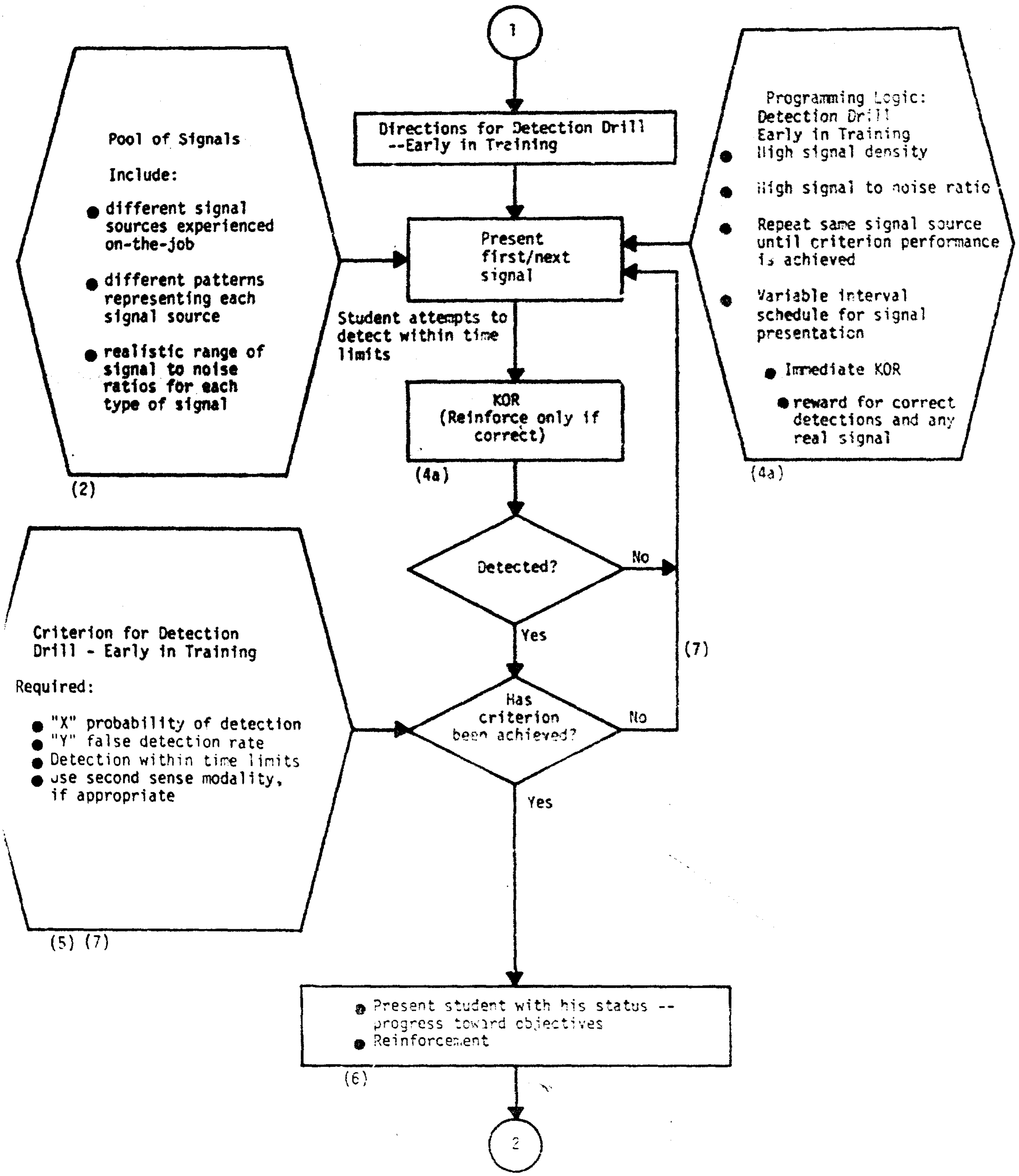


Figure 5. Learning Algorithm for Detecting (continued)

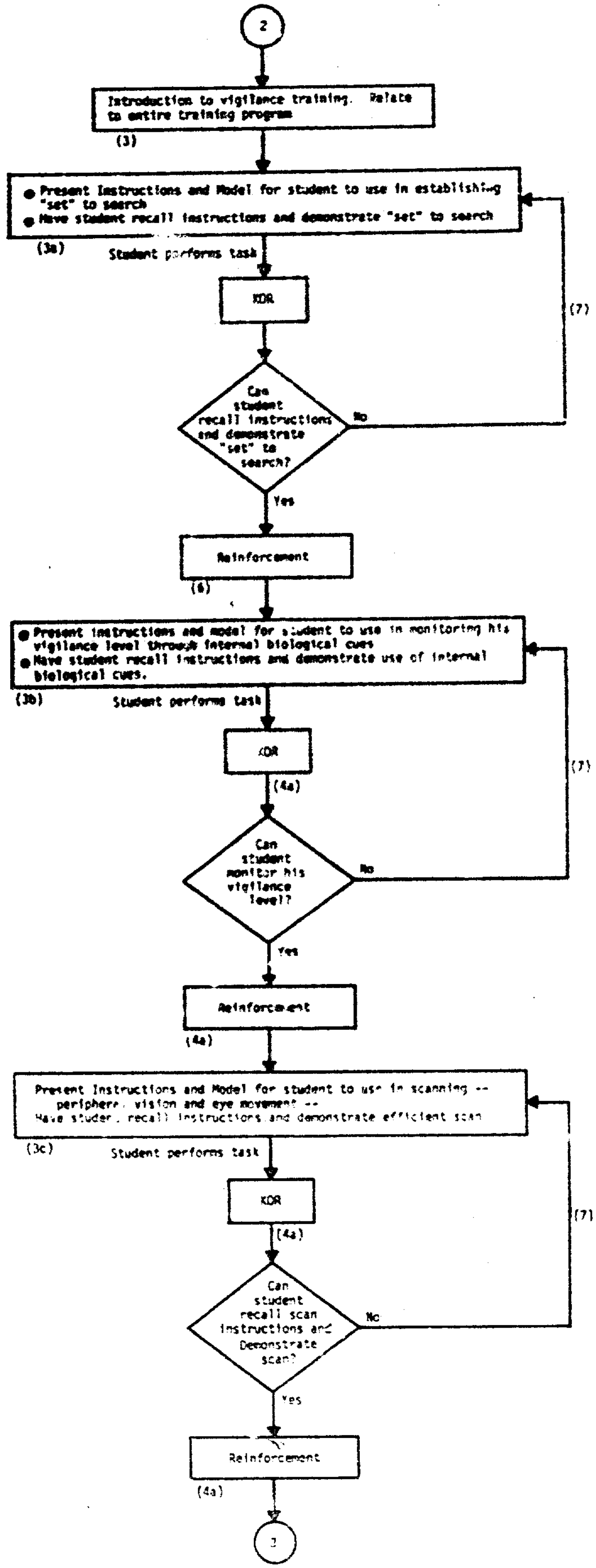


Figure 5. Learning Algorithm for Detecting (continued)

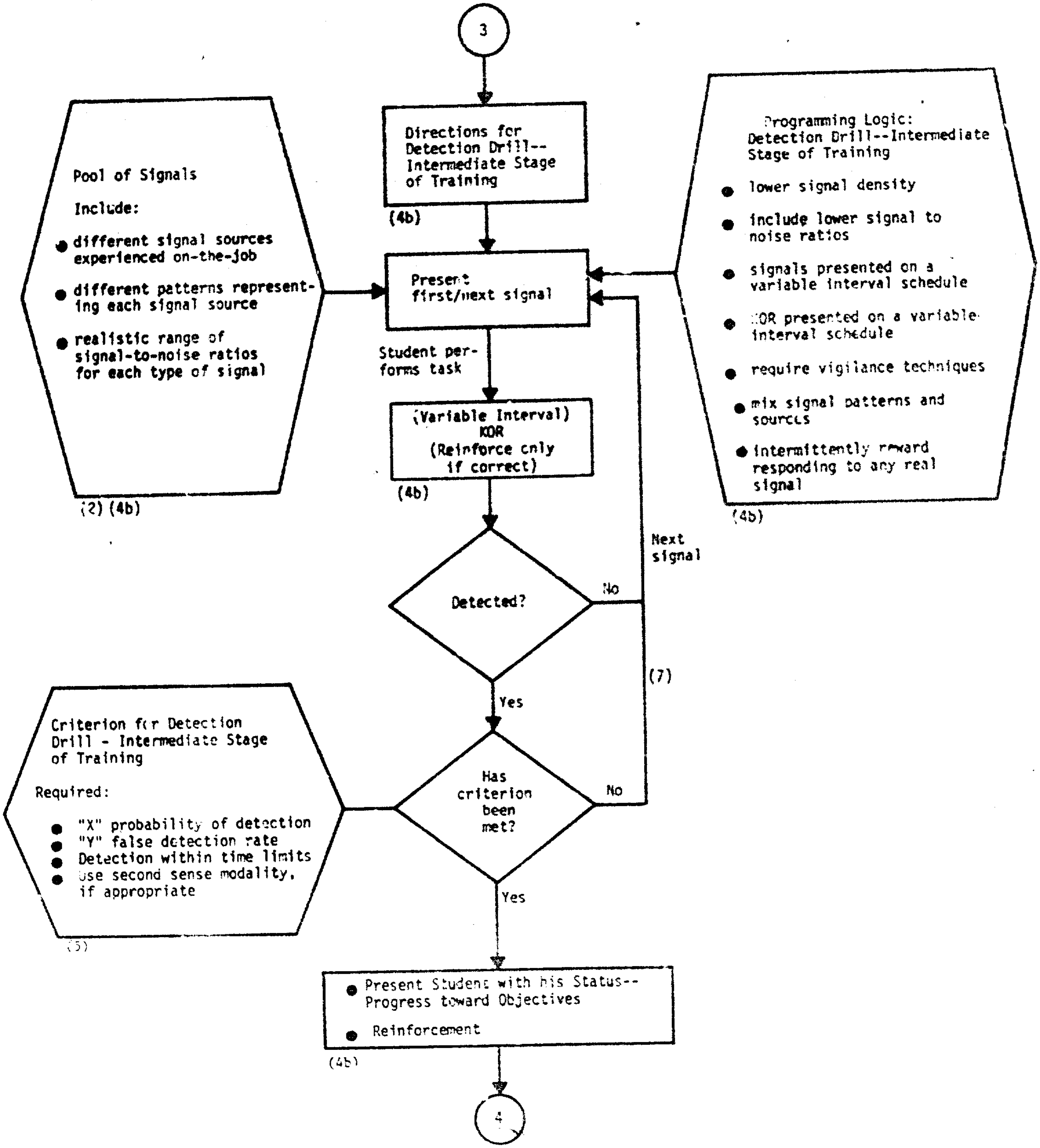


Figure 5. Learning Algorithm for Detecting (continued)

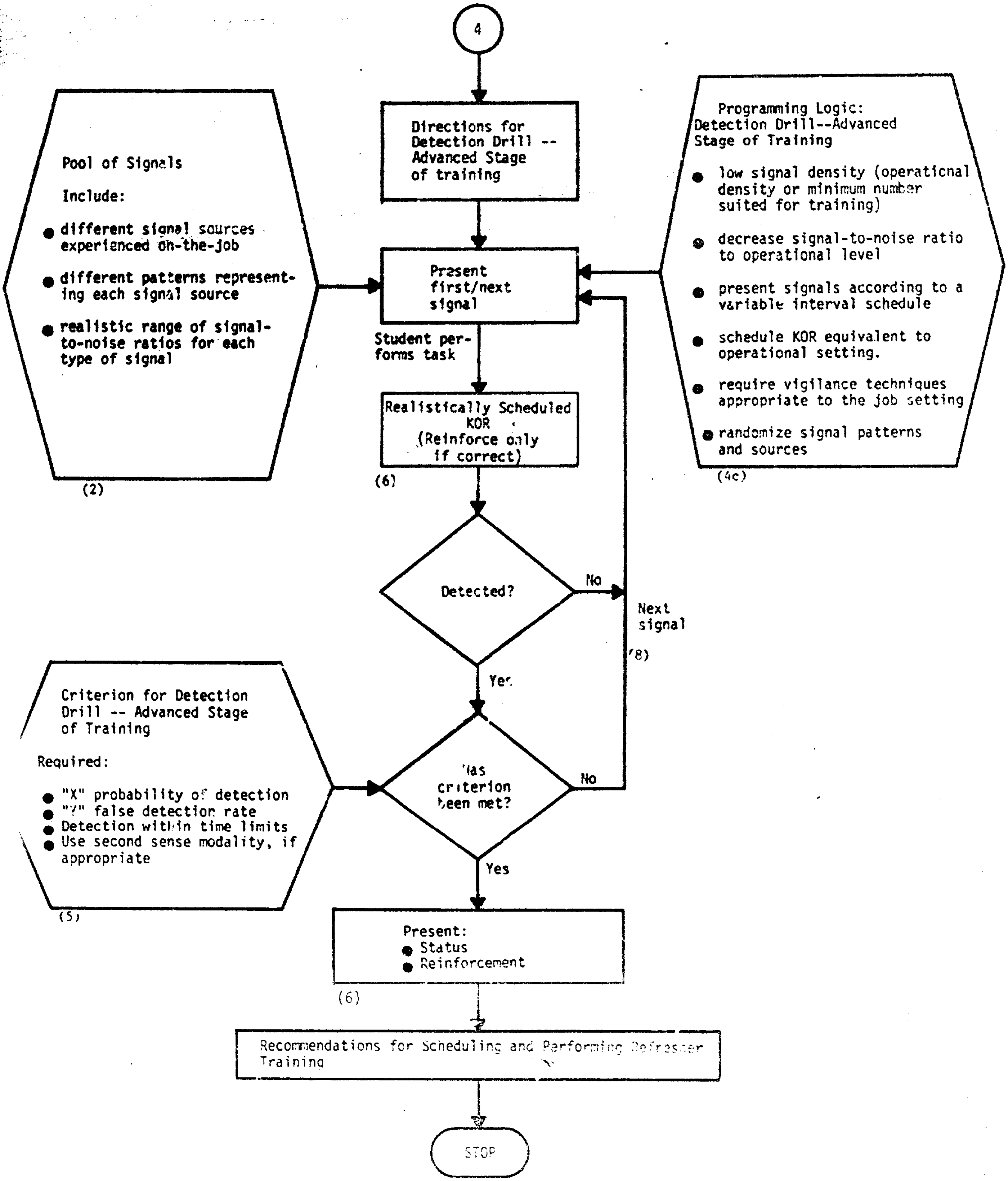


Figure 5. Learning Algorithm for Detecting (continued)

F. CLASSIFYING

This task involves assigning a name to detected signals based on identifiable characteristics. Classifying frequently follows immediately after detecting in the operational setting as if the two were a single event, although the two processes are fundamentally different. Classifying is closely related to the forming of concepts which has been extensively studied. In fact, to a large extent, the principles of learning which are applicable to concept formation also apply to classifying. Examples of classifying in operational tasks include labeling a sonar signal as "submarine" or "nonsubmarine," naming an approaching aircraft when the distinguishing features become visible, and determining that an increasingly louder "grinding" noise is a bearing starting to disintegrate.

The following guidelines apply to classifying. The algorithm representing these guidelines is presented in figure 6.

1. State clearly the behaviorial objectives to be achieved by the student. Organize learning material around critical cues (distinguishing features of the objects) to achieve this desired behavior. Relate the objectives to the student's future real-world assignments.

2. Train the student to properly differentiate features to be used in classifying. Make sure the student can observe the differences between closely related features if these differences are important in the classification task. (As an example, properly identify blue and blue-green as being different colors.)

3. Train the student to recognize the features of a pattern (cue) that distinguish this pattern from other patterns. Use cues that will be present in the student's job.

4. Emphasize distinctive cues which can be remembered in the form of mental pictures instead of abstract words. Teach the student to transform the distinctive features of cues into terms that he can readily recall.

5. Present examples of various classes in a single exercise. Towards the end of training, present examples of classes that appear very similar in the operational setting.

6. Minimize the number of irrelevant cues in the early stages of learning. Towards the end of training, increase the number of irrelevant cues to a maximum; i.e., corresponding to the real-life situation of the job.

7. Reinforce frequently in the early stages of learning pattern recognition. Reinforce less often (or same level as the operational setting) towards the end of training.

8. Ensure that the student practices making correct identifications of the test objects.

9. Provide immediate knowledge of results (KOR) to insure correct terminal performance.

10. Provide a pause following KOR (e.g., 4-12 sec.) that is much longer than the pause between the response and KOR (e.g., ½ sec.). This pause provides time for the student to sort out errors and to identify salient cues of the pattern.

11. Sample from the extremes of the full range of examples of patterns produced by a given object. Make the examples more similar as training progresses. At the end of training, the similarities in the examples should represent the similarities that exist in the real world.

12. Provide a variety of examples of the pattern. Select examples to sample the full range of variations in the pattern. Late in the learning stage, build in distractors equivalent to those found in the operational setting.

13. Provide self-paced training that can be adapted to the individual student's needs. Both rate and level of learning depend upon characteristics of the individual student.

14. Arrange for slow learners to have a higher number of reinforcements of correct responses than the fast learners.

15. Insure the development of a strong tendency for the student to look for certain critical and distinctive cue patterns found in operational tasks.

16. Require (where possible) the learner to correctly identify or cite new items as examples in each classification category.

17. Prevent decay of recall by (1) requiring the student to overlearn the original material and (2) ensuring periodic refresher training.

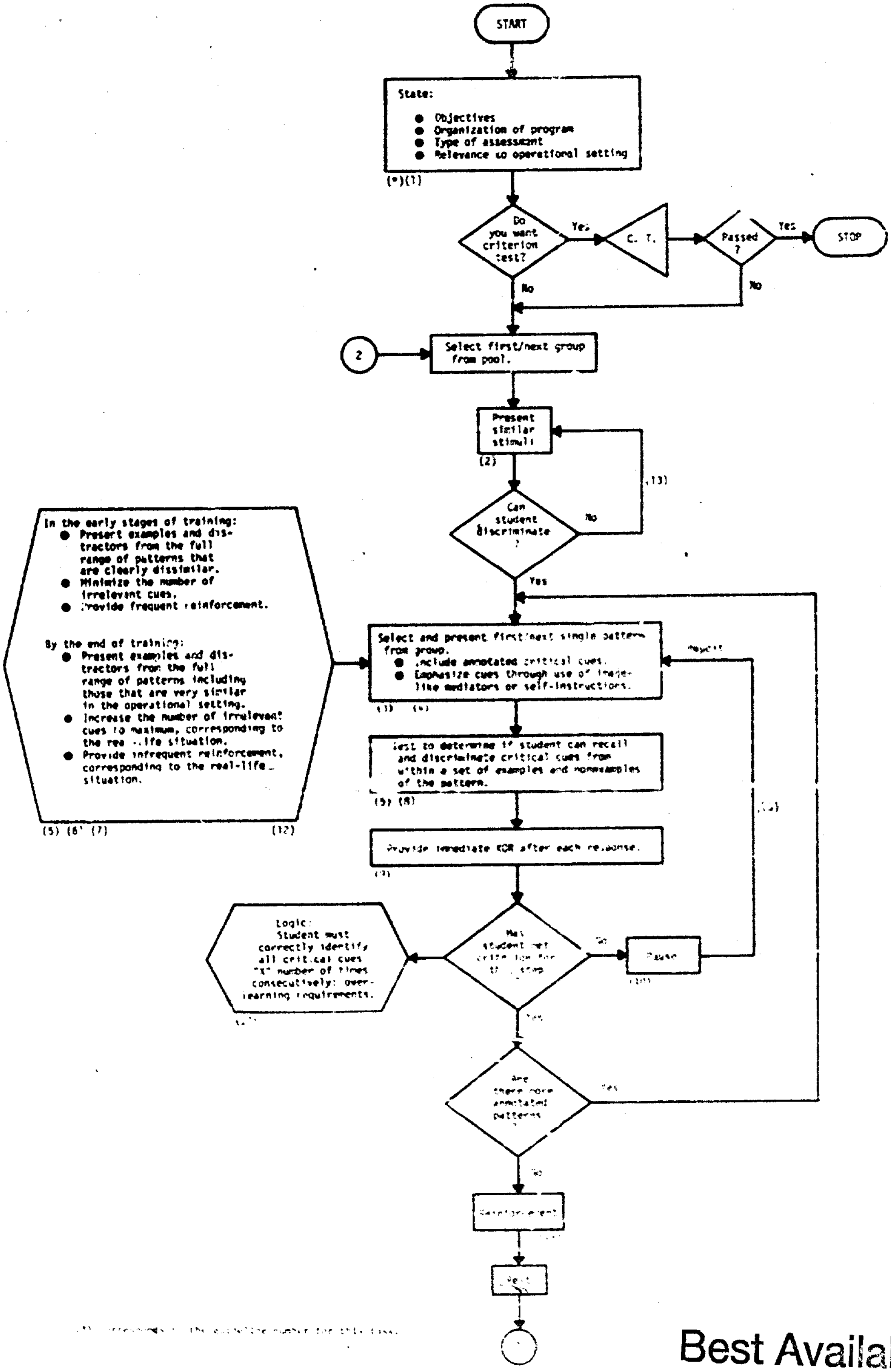
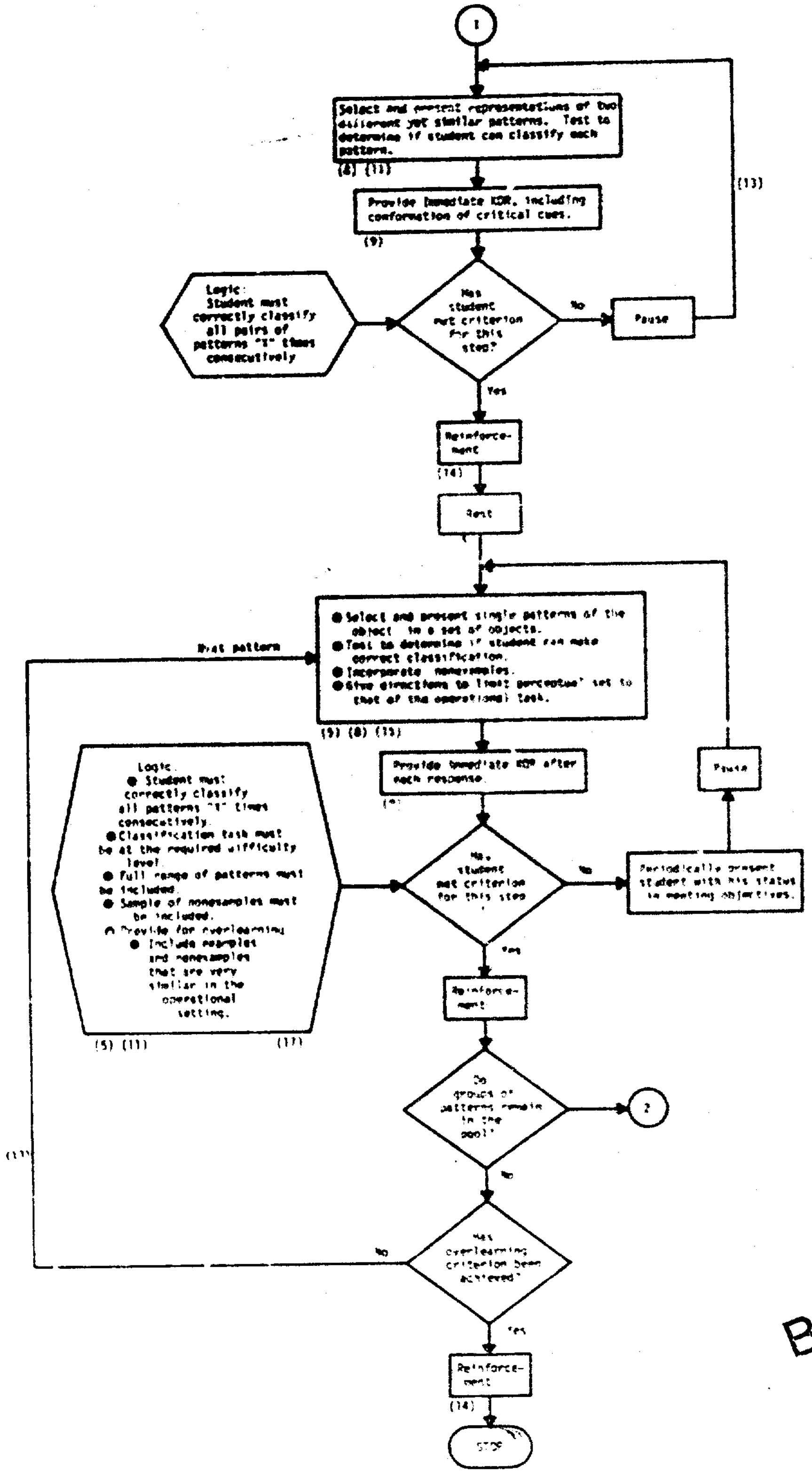


Figure 5. Learning Algorithm for Classifying



Best Available Copy

Figure 5. Learning Algorithm for Classifying (continued)

G. IDENTIFYING SYMBOLS

This category deals with recognizing and interpreting graphic characters such as those used in engineering drawings, maps, and status boards. Symbols serve as a brief code which must be decoded by the user. Most symbols have low meaningfulness to the untrained person. Symbol recognition is related to paired-associate learning, which has been the object of extensive research. The research literature supporting the guidelines for identifying symbols is considerable.

The guidelines for identifying symbols follow. The algorithm representing these guidelines is presented in figure 7.

1. Relate training clearly to meaningful and job related tasks.

2. Show differences between similar individual features of symbols. Do this before associating these symbols with identification responses.

3. Break up the total list of symbols into smaller sets when any of the following conditions exist:

   a. A long list of symbols is to be learned.

   b. Material is complex for students.

The size of the set for each student should vary according to how much each of the factors departs from the normal situation for each condition.

4. Present the associate item (or meaning) immediately after the symbol in time as the basis for this kind of training.

5. Randomize the order of the presentation of the symbols to the student so that all symbols will be learned equally well.

6. Use mnemonics (associating recall of symbols with imagery, rhymes or rhythms) for difficult to recall symbols. Provide mnemonics which will cause an affective reaction in the student. Also provide directions for the student to develop his own mnemonics.

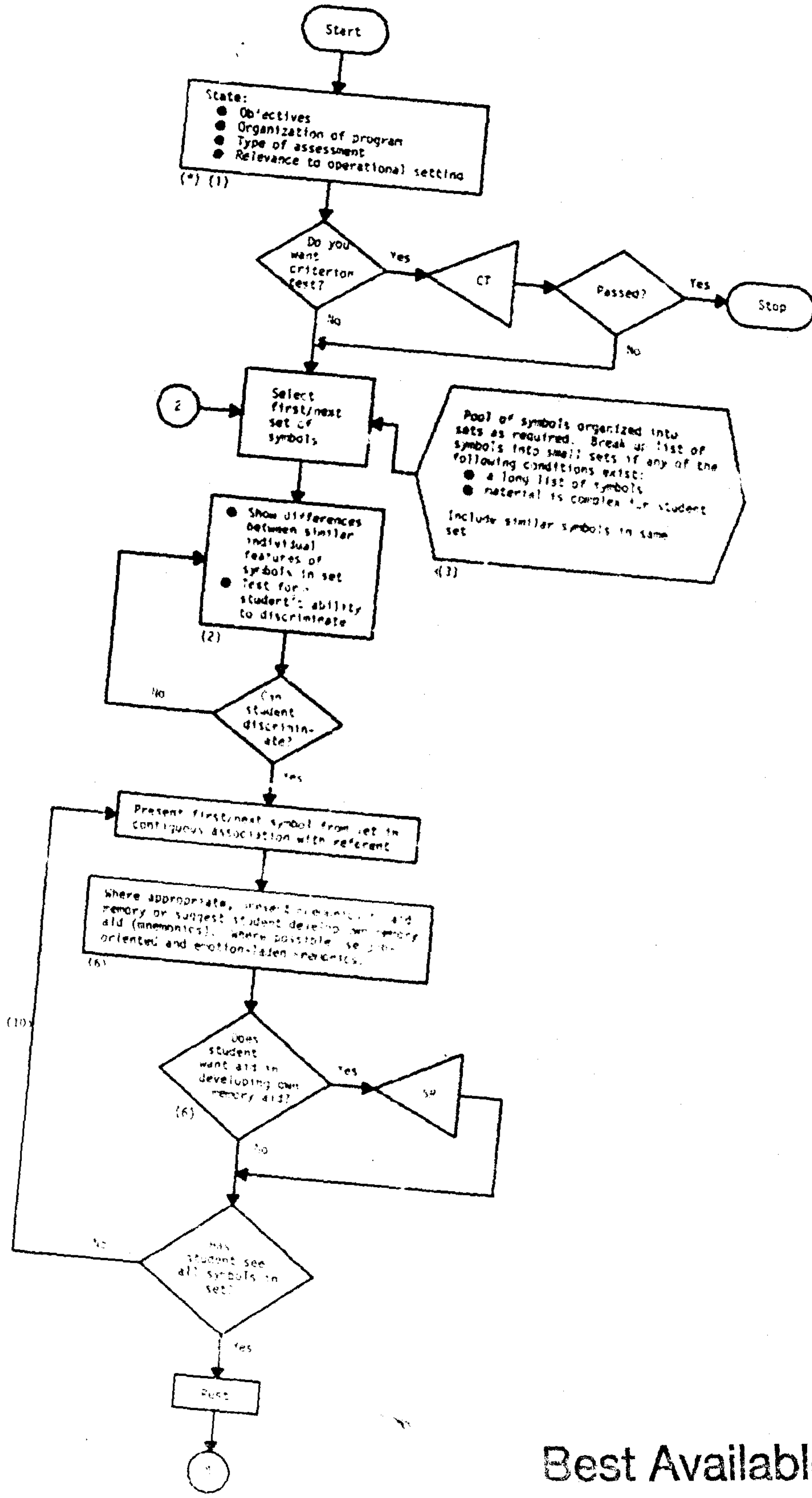
7. Allow for self-paced practice with knowledge of results (KOR).

8. Prevent decay of recall by (1) requiring the student to overlearn the original associations and (2) ensuring periodic refresher training.

9. Test for correct identification of symbols by measuring overt performance by the student.

10. Provide self-paced training that can be adapted to the individual student's needs. Both rate and level of learning depend upon the characteristics of the individual student.

11. Use immediate KOR and frequent reinforcement in the early stages of training. In later stages of training, match the KOR and reinforcement levels that exist in the operational setting.



(*) Corresponds to the guideline number for this task.

Figure 7. Learning Algorithm for Identifying Symbols

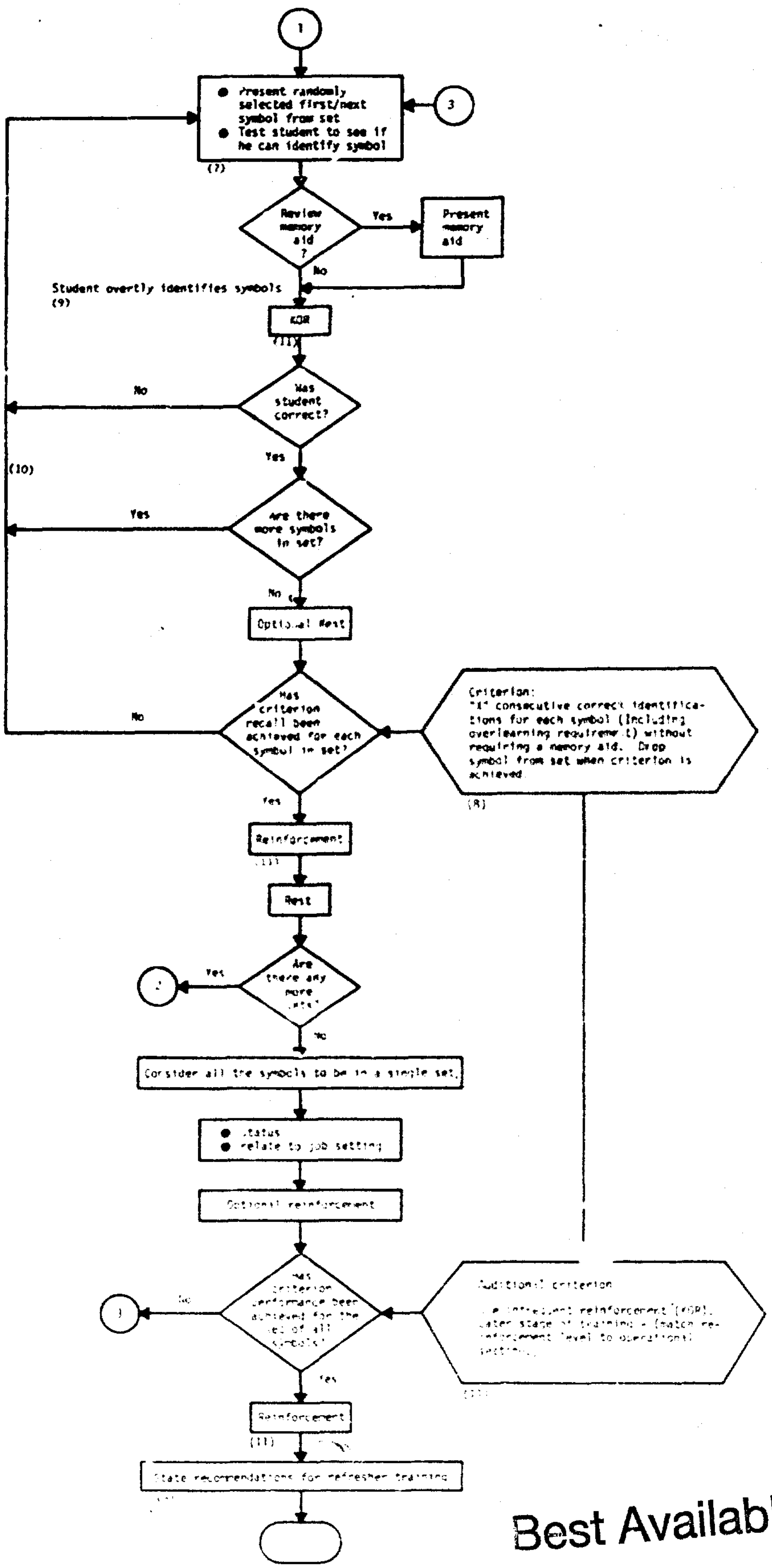


Figure 7. Learning Algorithm for Identifying Symbols (continued)

H. VOICE COMMUNICATING

Voice communication is used here to mean a conversation between people in which standardized message formats are employed. A person has typically been overtrained in speaking and listening as a part of every day living. Certain conversation patterns must be changed in order to effectively communicate within the military tactical environment. In this setting, messages must be brief and have a single meaning. The timing of when to pass the essential information is frequently critical. The task may be made more difficult due to the presence of background noise and other conversations on the communication circuit. Clarity of enunciation is important. Most of the guidelines are based upon general learning principles. In addition, principles identified through analysis of voice communicating are used.

The following guidelines are presented for voice communicating. The algorithm representing these guidelines is presented in figure 8.

1. Present objectives of the learning program to the student. Organize material around objectives. Relate material to the operational setting of voice communication.

2. Present a brief overview of the learning program.

3. Break up the material into discrete voice communication categories that frequently occur in the job setting.

4. Identify similar cues (usually auditory) that frequently are confused in voice communication tasks and test the student to see if he can discriminate among them.

5. Point out critical cues and responses that are different from the student's habitual ("everyday" type) voice communication.

6. Teach the student to anticipate certain messages in a given operational setting - listen for certain words.

7. Teach voice communication procedures and terminology in general using Recalling Bodies of Knowledge Guidelines before presenting a demonstration of each specific procedure.

8. Demonstrate each voice procedure with a model performance; insure that the student observes the critical cues and responses in the model's demonstration.

9. Require the student to practice until he demonstrates the correct performance. Have him concentrate his practice on the parts he finds difficult.

10. Give specific knowledge of results with each performance of the student; reinforce correct segments of performance.

11. Provide rest periods at intervals within the training period.

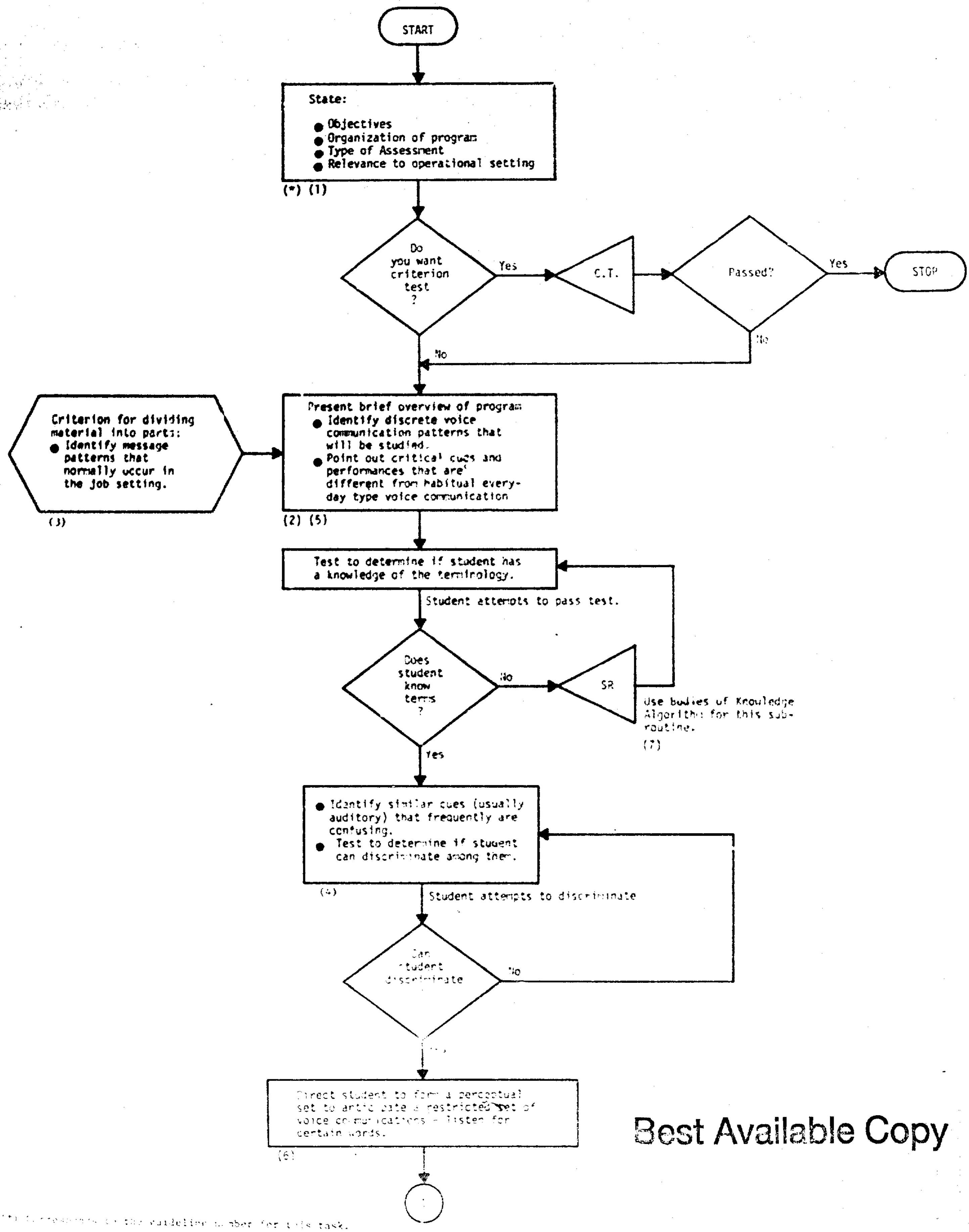
12. Increase distractors and stress conditions equal to that in the operational setting during the later stages of voice communication training.

13. Practice voice communication procedures to the same skill level that will be required in the operational setting.

14. Require student to overlearn correct voice communication procedures so that he can perform them correctly in a distracting, stressful environmental setting.

15. Reinforce the student for meeting the overlearning and operational performance criteria.

16. Insure periodic refresher training where it is indicated by the performance of the person on the job.



(*) Corresponds to the guideline number for this task.

Figure 8. Learning Algorithm for Voice Communicating

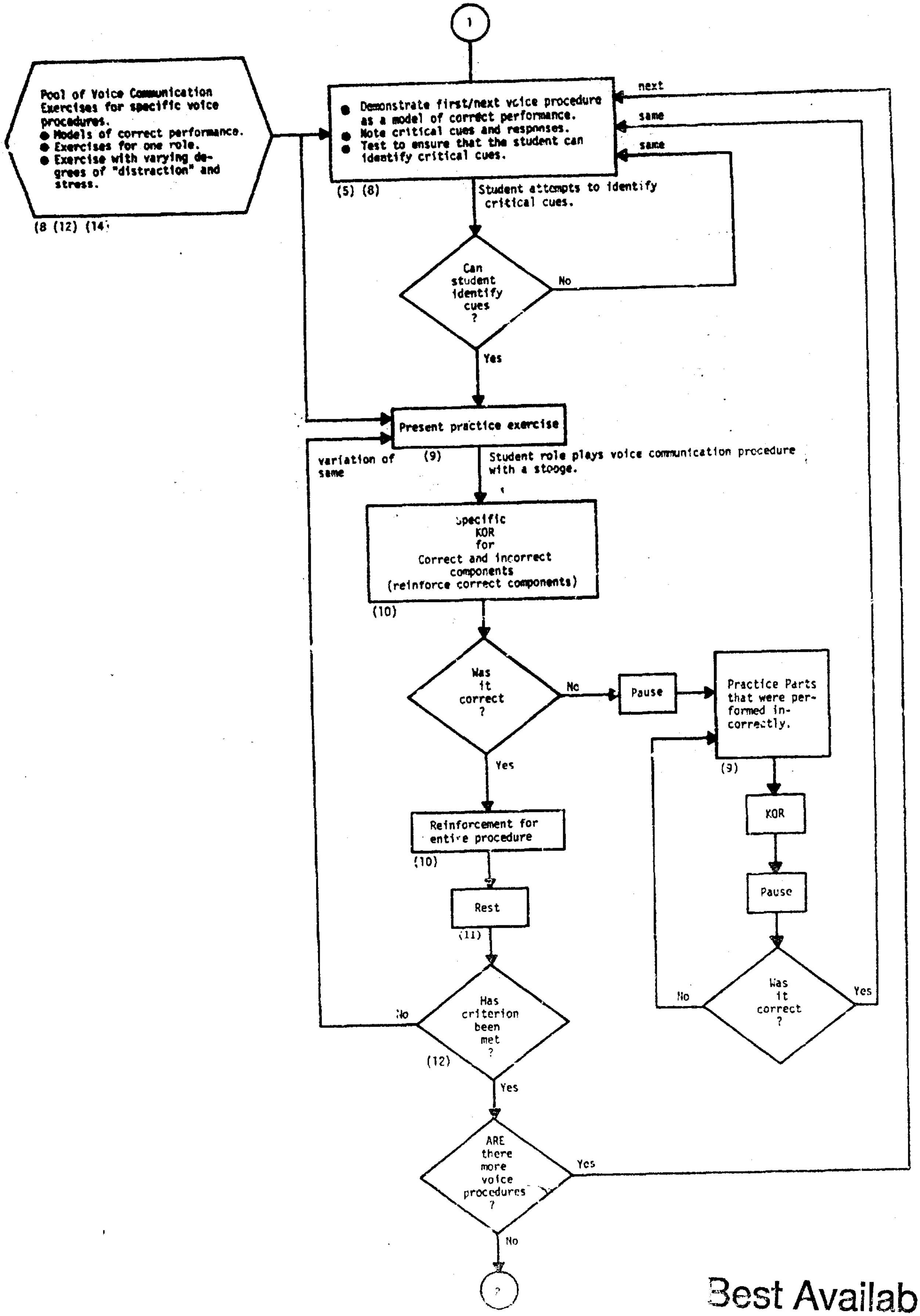
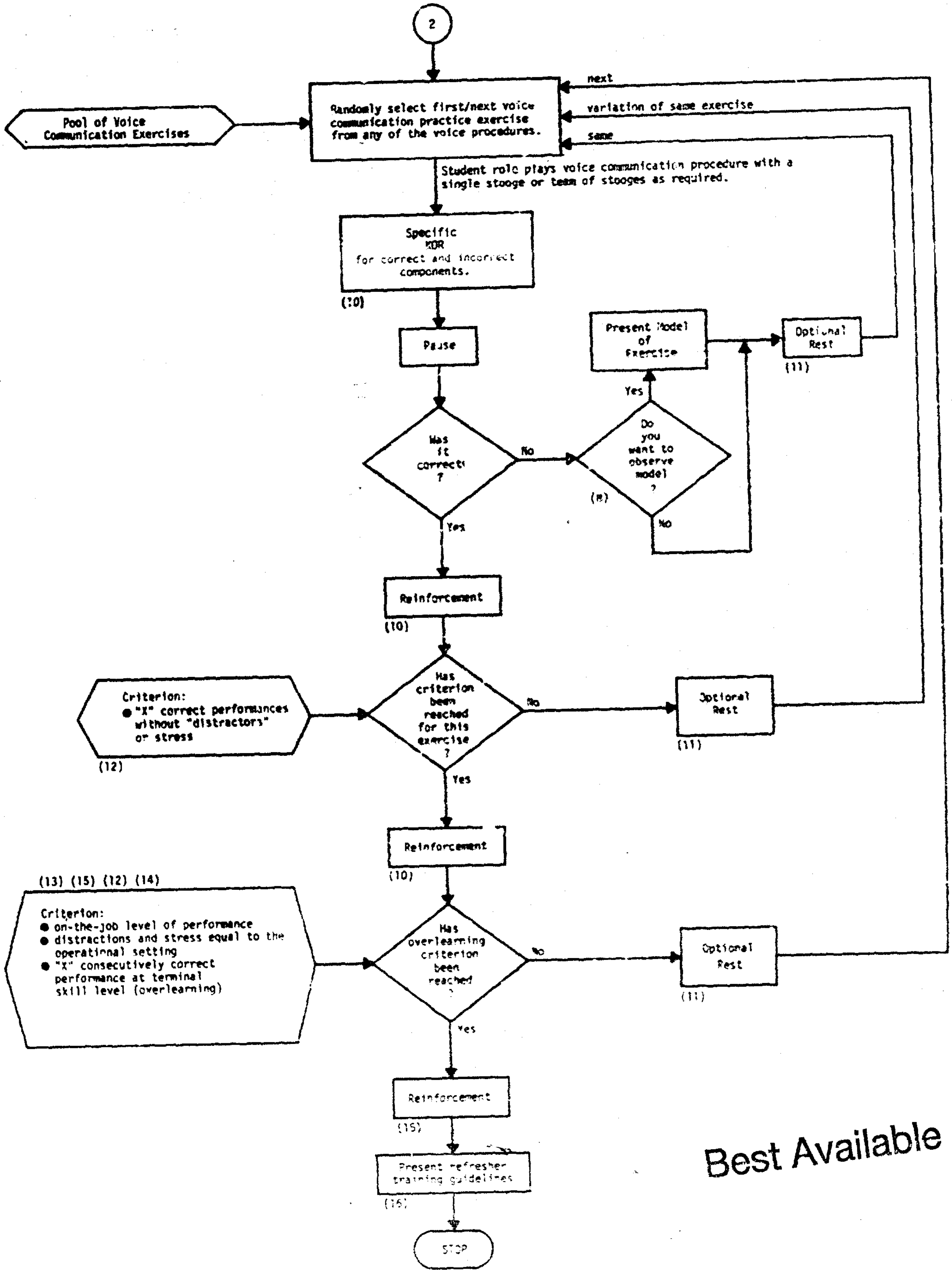


Figure 8. Learning Algorithm for Voice Communicating (continued)



Best Available Copy

Figure 8. Learning Algorithm for Voice Communicating (continued)

I. RECALLING PROCEDURES AND POSITIONING MOVEMENT

This task category combines two quite different kinds of tasks. Recalling procedures is basically a mental skill, whereas positioning movement is a physical skill. They are combined in these guidelines since they often occur together in the operational setting. They concern carrying out routinized activity, executed as standard operating procedures in some predetermined sequence. Relatively little judgment and analysis are required and a minimum of alternative behavior is involved. Controls are manipulated in an identifiable procedural sequence. Motor movements for control positioning are, at the outset, within the response repertoire of the student; therefore, the emphasis is placed on recalling the sequential procedures and on the accuracy of the positioning movements. An example is the checkout of a piece of communication equipment using a checklist to determine if the equipment is operating within acceptable tolerances. These types of tasks are common and have often been studied with the goal of improving training efficiency.

Guidelines for this behavior are listed below. The algorithm representing these guidelines is presented in figure 9.

1. State clearly the behavioral objectives to be achieved. Describe how the learning materials are organized to achieve this desired behavior. Relate the objectives to the student's future real-world assignments.

2. Break the positioning movement task into appropriate parts and provide subdivisions of organization for each procedure.

3. Divide the procedural steps into small parts if any of the following conditions exist:

   a. Students are of low ability,

   b. The procedures are complex,

   c. The entire procedure is lengthy.

4. Present a demonstration of each task performance (a positioning response to a checklist cue) on an observable model.

5. Show checklist cues and require the student to explain differences in similar cues that serve as association devices for different procedures that have been confused in the past.

6. Use mnemonics which will cause an affective reaction in the student whenever possible to aid in the recall of the procedures to be learned for this task.

7. Use mnemonics (associating procedural steps with imagery, rhymes, or rhythms) to aid in recalling difficult to remember steps. Provide directions for the student to develop his own mnemonics where he is able and willing to do it.

8. Direct the student to practice the following sequence of events to help him remember a chain of procedures.

a. When presented with each checklist item, explain (or perform) its corresponding procedural step.

b. Then when presented with a group of checklist items (as many as the student can handle at once) explain or perform their corresponding procedural steps. The first item of each group should overlap the last item of the previously studied group of steps.

c. Then when presented with a single list of all of the checklist items in the entire procedure, explain (or perform) their corresponding procedural steps.

9. Encourage students to mentally rehearse the procedures called for by the steps in the checklist using mnemonics to aid in the recall of these procedures.

10. Ensure extensive practice early in the training by requiring the learner to:

a. Understand the objective(s),

b. Observe the skilled performance of a model,

c. Strengthen the individual (or component) steps of the desired movement by practicing these steps, obtaining knowledge of results (KOR) and by correcting performance errors.

d. Integrate the steps into a smooth sequence of positioning movements by practicing the sequence of steps.

11. Provide the following conditions for corresponding stages of training:

a. Early in training use:

(1) immediate and frequent KOR,

(2) immediate and frequent reinforcement,

(3) little or no operational distractors,

(4) learning material broken-down into small, easily learned parts,

(5) items required to be learned which are relatively easy to acquire,

(6) guiding or prompting of responses.

b. Late in training:

(1) use delayed and infrequent KOR,

(2) use delayed and infrequent reinforcement,

(3) increase distractors to operational level,

(4) a given procedure will be required to be recalled (or performed) in response to the same cues as on the job.

(5) the level of complexity of the procedural cues and distractor cues should be the same as on the job. Add stressful conditions equivalent to that in the operational setting,

(6) eliminate guides or prompts (other than those provided in the operational setting).

12. Make the time interval following KOR much longer than the time interval between the response and KOR, to provide time for the student to sort out errors.

13. Identify features of the operational environment which could be used as mediators to trigger the student's recall of checklist items.

14. Practice should be distributed; i.e., the timing of rest periods should be determined by:

a. need for rest as judged by the student.

b. requirements of the specific learning material as judged by the instructor.

15. Arrange for extensive repetition (overlearning) by the student to take advantage of the internal feedback properties generated by performing these types of tasks (positioning movement) accompanied by external feedback. Simple repetitive movements may become reinforcing; i.e., the student experiences feelings in muscle and joints which he identifies as cues that he is performing the task correctly.

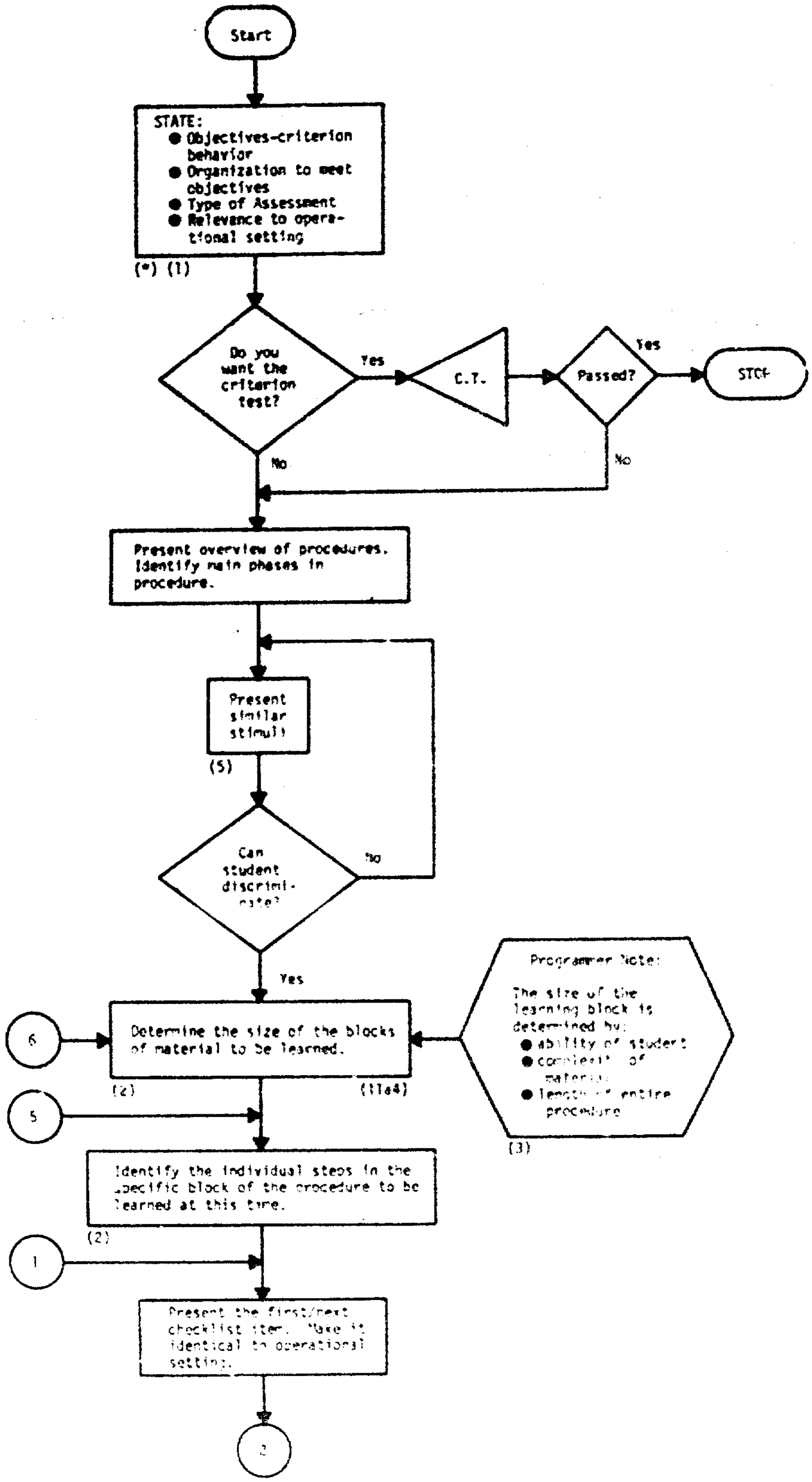
16. Arrange for slow learners to have a higher number of reinforcements of correct responses than the fast learners.

17. Maximize the realism of checklist items and their corresponding procedural responses.

18. Arrange for the student to compare the program objectives with his current status in meeting these objectives (use periodically).

19. Train the student to the operational criterion; i.e., insure that acquisition of the procedural material will be to the level of performance required for on-the-job duties.

20. Prevent decay of recall by providing periodic refresher training for infrequently used procedures.



(*) corresponds to the guideline number for this task.

Figure 9. Learning Algorithm for Recalling Procedures and Positioning Movement

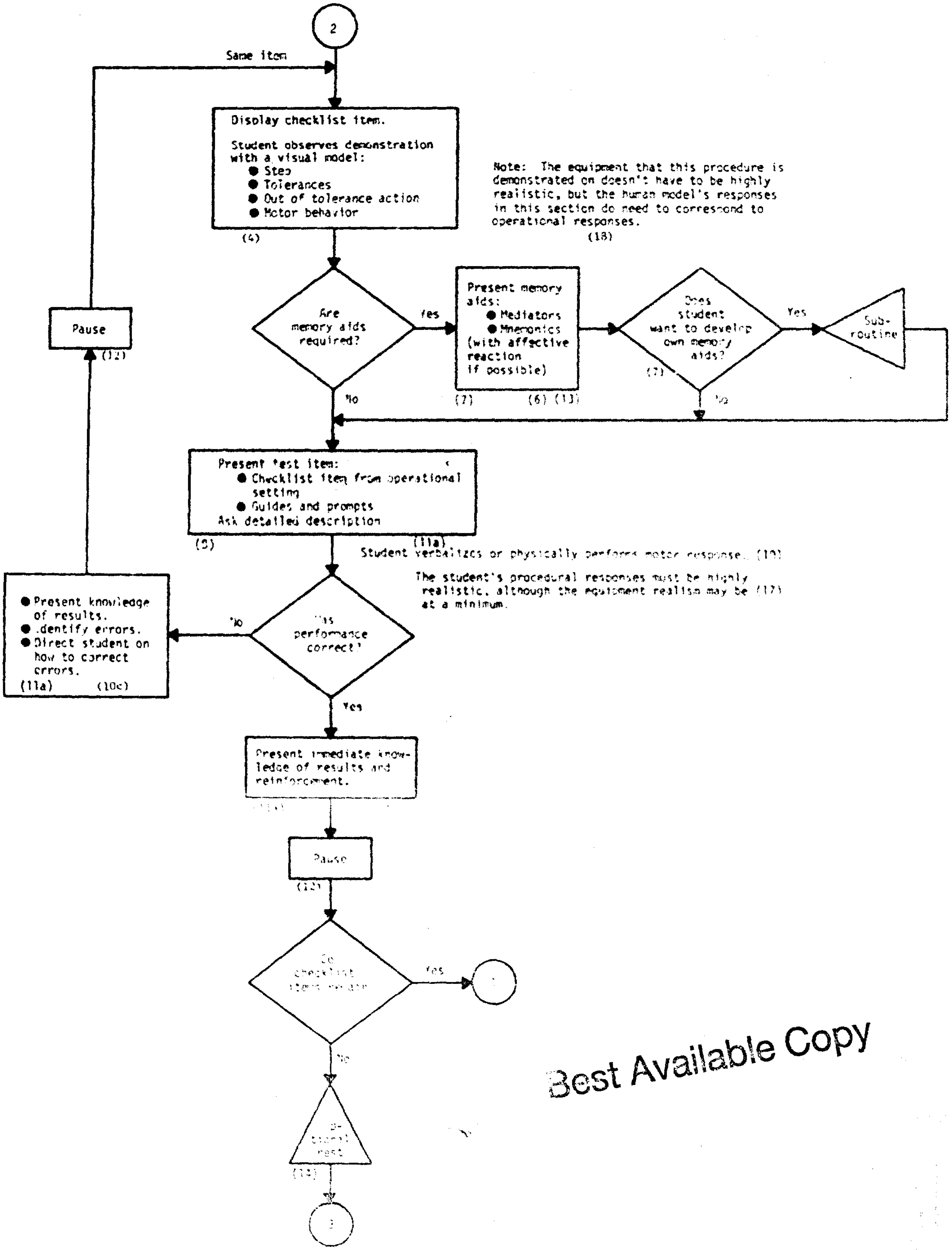


Figure 9. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

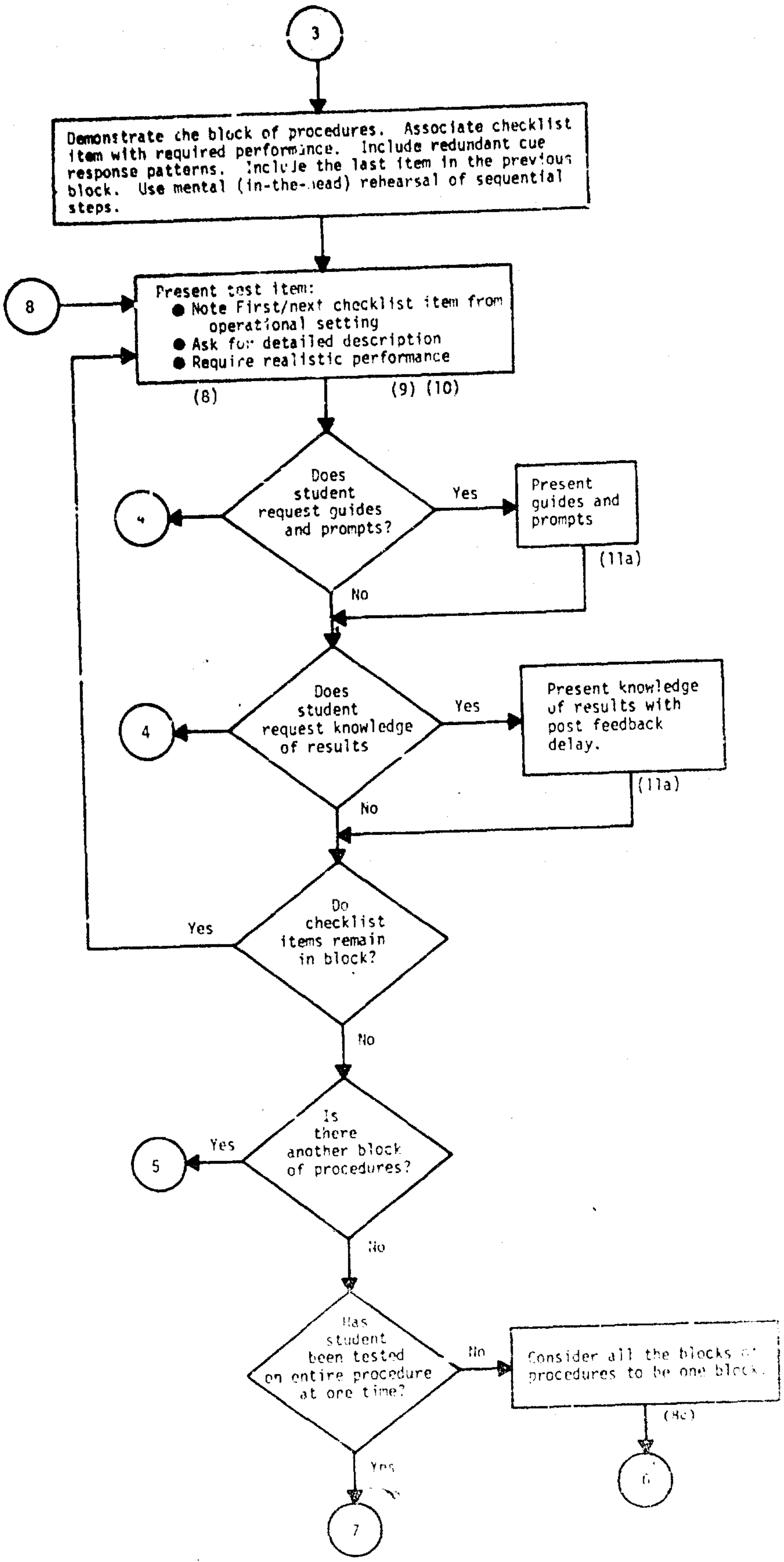


Figure 9. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

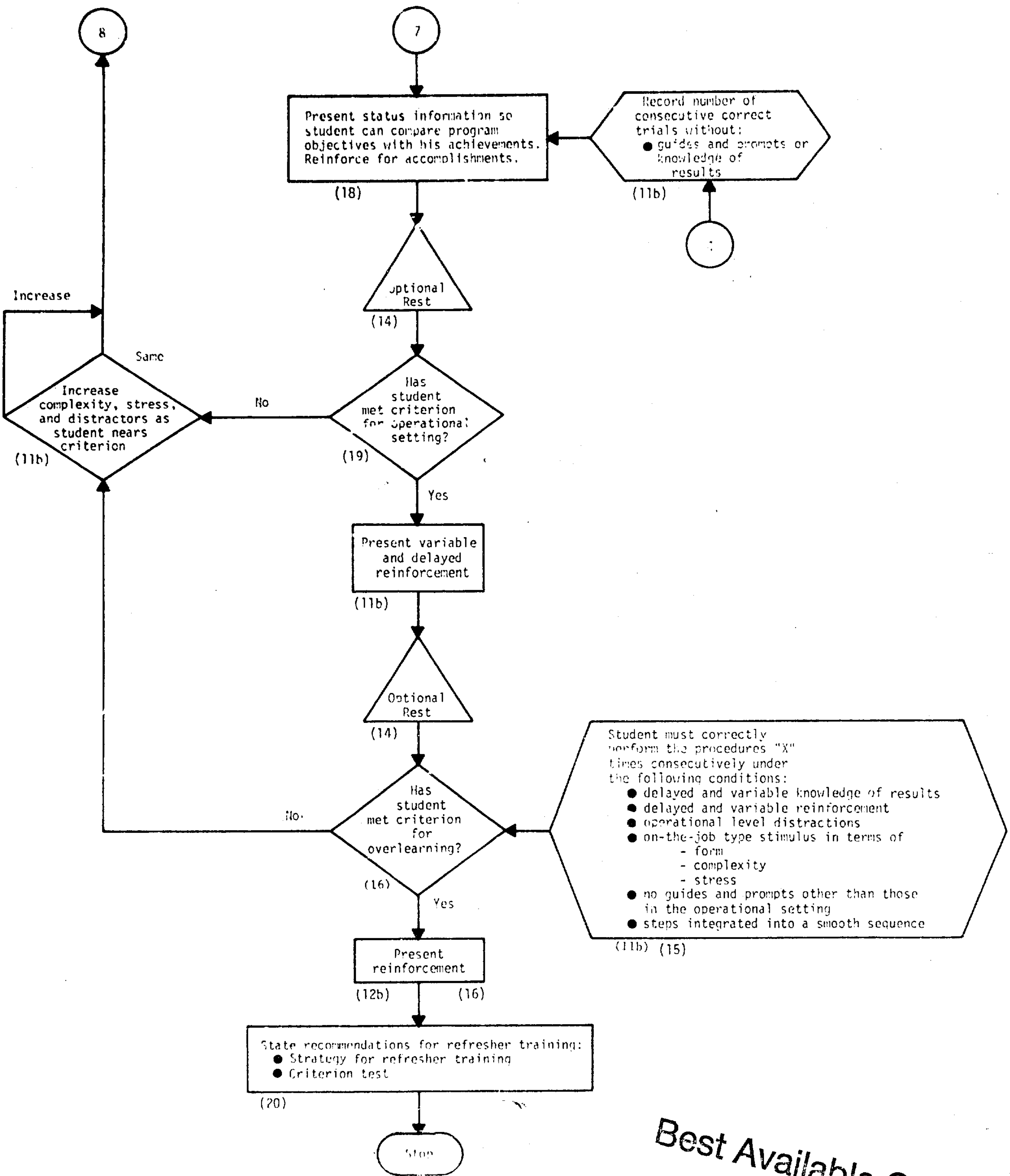


Figure 9. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

J. GUIDING AND STEERING, CONTINUOUS MOVEMENT

This type of task concerns continuous physical response to a constantly moving visual reference. Frequently it involves controlling the path of a moving vehicle. Examples include maneuvering an automobile down a road, visually aiming weapons during air-to-air combat, holding a ship on course using a gyro compass. Many military jobs involve this type of behavior. Because of the high cost of vehicle control training performed on the operational systems, how best to train this type of behavior has been carefully studied. Proprioceptive stimulation arising in the muscles, tendons, and joints is normally present and is one of the primary sources of information used in controlling the force, extent, and duration of a movement. Perceptual discrimination skills are involved, including the detection of relevant cues (via sight, hearing, touch, etc.). Models of correct behavior are usually used in the training of this task. They serve as guides and criteria against which to evaluate one's own behavior. These models include rules, self-directions, and cues of adequate performance. As the student's skill increases in continuous movement tasks, a high degree of internal control is developed; i.e., the routine tasks are performed smoothly with little conscious effort, and conscious control governs increasingly larger blocks of behavior.

The following guidelines have been defined for training continuous movement tasks. The algorithm representing these guidelines is presented in figure 10.

1. State clearly the criterion behavior or objective to be achieved. Relate the objective to the student's future real-world assignments. Provide him with an overview of desired movements.

2. Break the task up into appropriate parts. (Use as criteria to determine the size of these parts: ability of learner, complexity, and length of task.)

3. Ensure that the critical external cues are realistic and available to the student continually during the performance of the task, particularly during the latter part of the training.

4. Provide training to scan by specific training of eye movement and where to focus for scanning.

5. Insure a high degree of realism in the operator's response in training for continuous controlling tasks.

6. Demonstrate the desired task performance with a model.

7. Provide for extensive practice to achieve skilled performance. Practice should contain (a) understanding skill objectives, (b) observing skilled performances, (c) practicing the task, (d) obtaining knowledge of results (KOR), and (e) scheduling periodic rest intervals.

8. Provide reinforcement contingent upon characteristics of the student's response so that by a process of "successive approximations" the final desired proficiency (within acceptable tolerances) is produced.

9. Give KOR concerning discrete segments of student performance, especially during early stages of learning.

10. Give positive reinforcement after correct student performance; initially, immediately after each discrete segment of performance; toward the end of training, after each maneuver or complete operation.

11. Practice on specific components when learning a complex task, as opposed to practicing on the entire task at once.

12. Practice under the varied conditions that will exist in the operational setting, if possible.

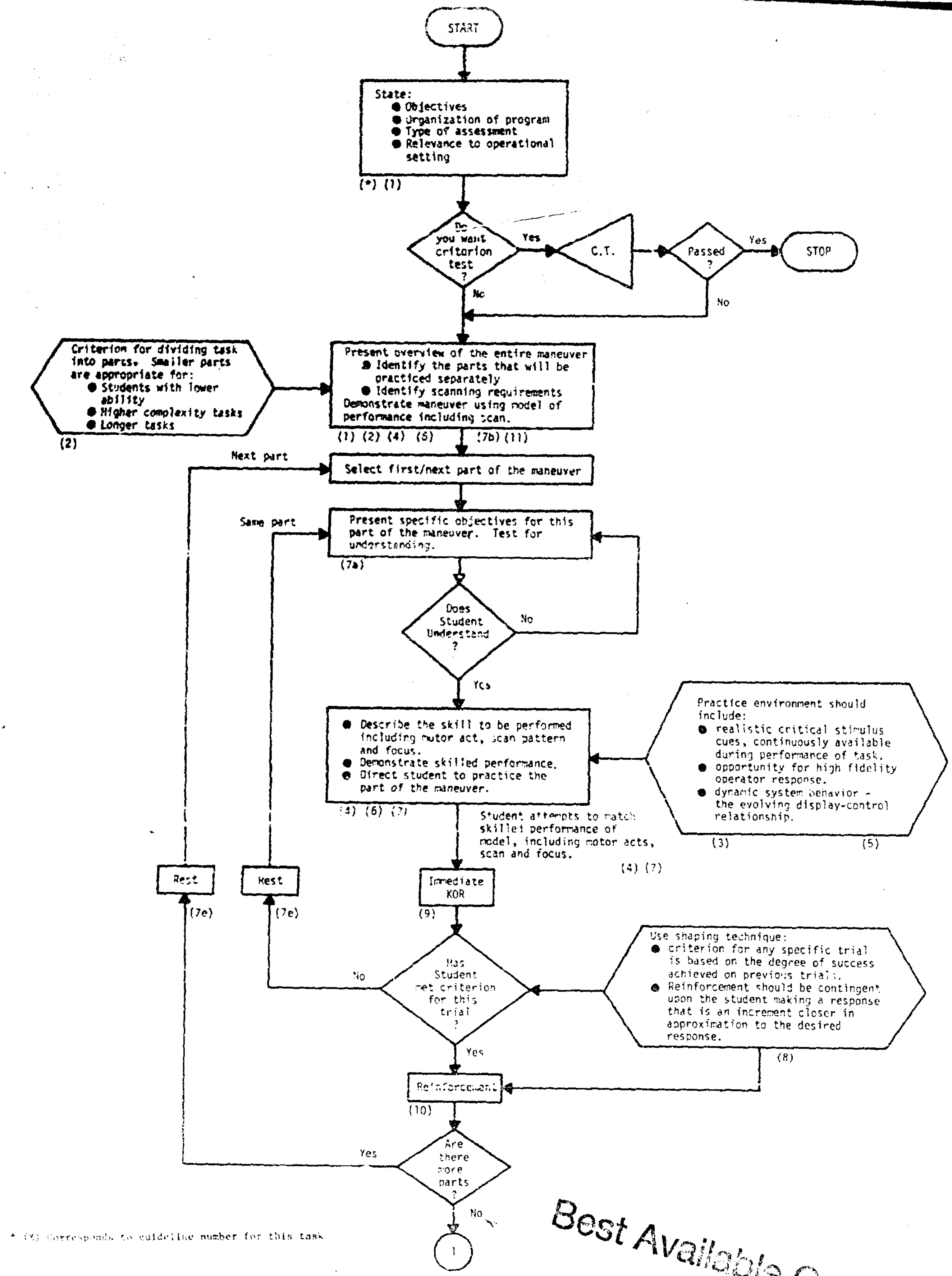
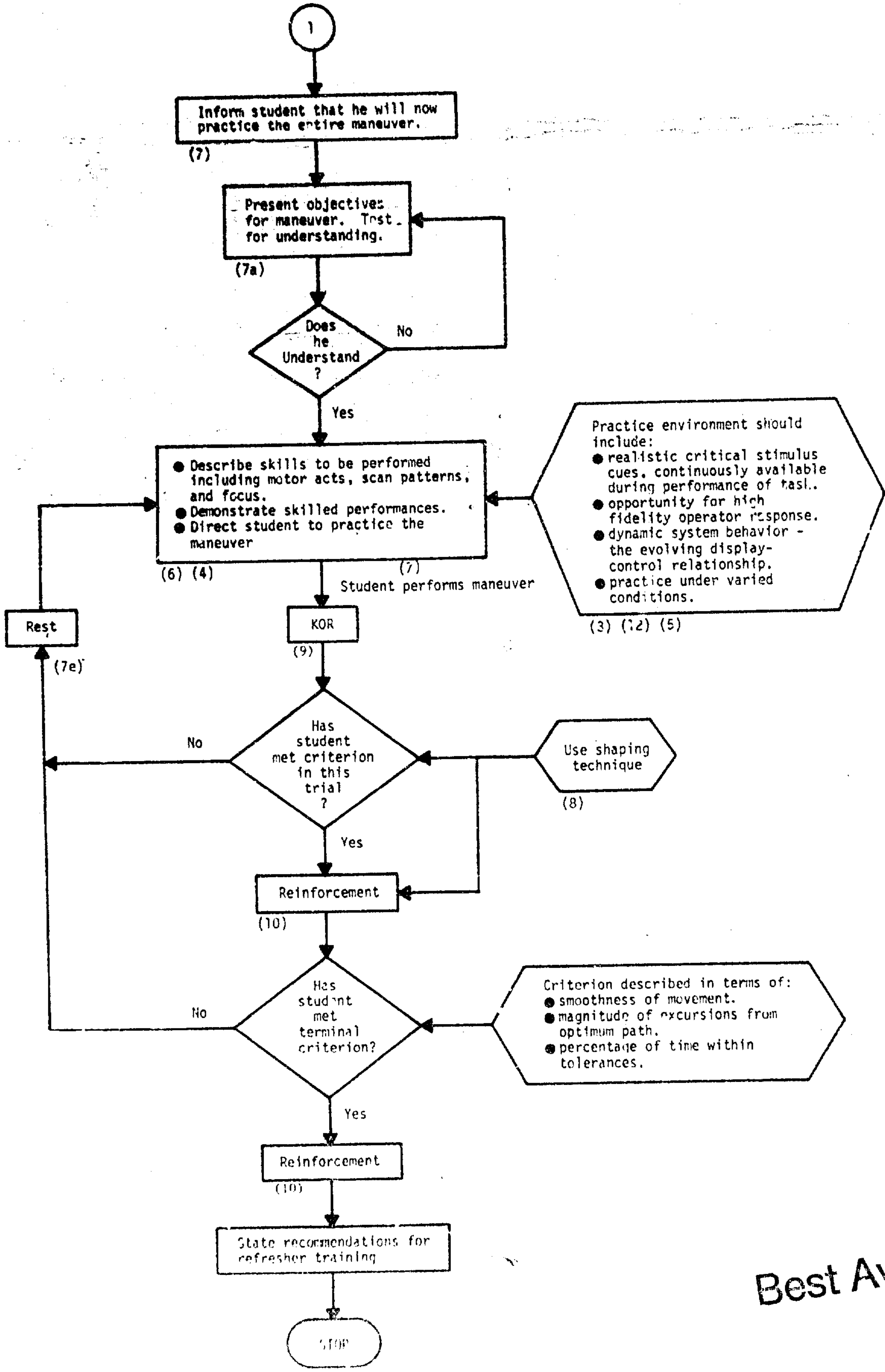


Figure 10. Learning Algorithm for Guiding and Steering, Continuous Movement



10. Learning Algorithm for Guiding and Steering, Continuous Movement (Continued)

K. PERFORMING GROSS MOTOR SKILLS

This category includes skills characterized by repetitive motor acts involving the use of large muscles. It often includes chaining of movements and a low level of attention by the skillful performer. Fatigue may become a factor in the performance of these skills when performed over an extended period of time. Examples include body movements in many athletic events such as running, swimming, and jumping. These motor acts are controlled by various forms of internal and external stimuli. Proprioceptive stimulation arising in the muscles, tendons, and joints is a primary source of information used in directing this type of skill. Perceptual discrimination including the detection of relevant external cues is secondary to successful performance. As in other types of motor skills, conceptual models of correct behavior are usually used as a performance guide and as a baseline for self-evaluation. A high degree of internal and unconscious control governs the discrete acts in this type of skilled behavior.

The guidelines for performing gross motor skills are listed below. The algorithm representing these guidelines is presented in figure 11.

1. Orient student to the learning task by:

   a. Stating the objectives,

   b. Relating the objectives to the operational task he will be performing.

2. Teach the student to discriminate among similar cues within each of these classes:

   a. Objects in the job environment to which the performer must respond with appropriate action (external cues).

   b. Proprioceptive stimuli (internal cues).

3. Facilitate the student's understanding of the task by requiring him to do the following:

   a. Observe a demonstration of the task.

   b. Observe the component parts of the task as it is being presented,

   c. Have the student describe and demonstrate the component parts of the motor task which he observed.

4. Require that the student practice with regard to the following considerations:

a. Practice a simple task in its entirety, or a complex task in parts and then in its entirety.

b. Practice under varied operational conditions. This is done to help adapt the performance of this task to potential environmental changes in the operational setting.

c. Ensure that during practice the student:

(1) Understands the objectives of the skill while learning,

(2) Observes a skilled performance of the desired task as often as necessary,

(3) Obtains feedback concerning his performance of the task (immediate feedback early in training, and a level of feedback appropriate to the operational setting later in training). Encourage the student to respond to internal feedback.

d. Distribute the practice; i.e., provide for rest intervals during training.

5. Ensure that feedback of the following kinds will be provided:

a. Evaluative--student learns what he is doing that is correct or incorrect.

b. Comparative--student learns how his performance compares to the objectives and standard of performance required in the operational setting.

6. Provide a pause of a few seconds after feedback has been given following performance of the motor skill to allow sorting out of errors made during the training performance.

7. Shape the desired performance by reinforcing the student's closest approximation to the desired response.

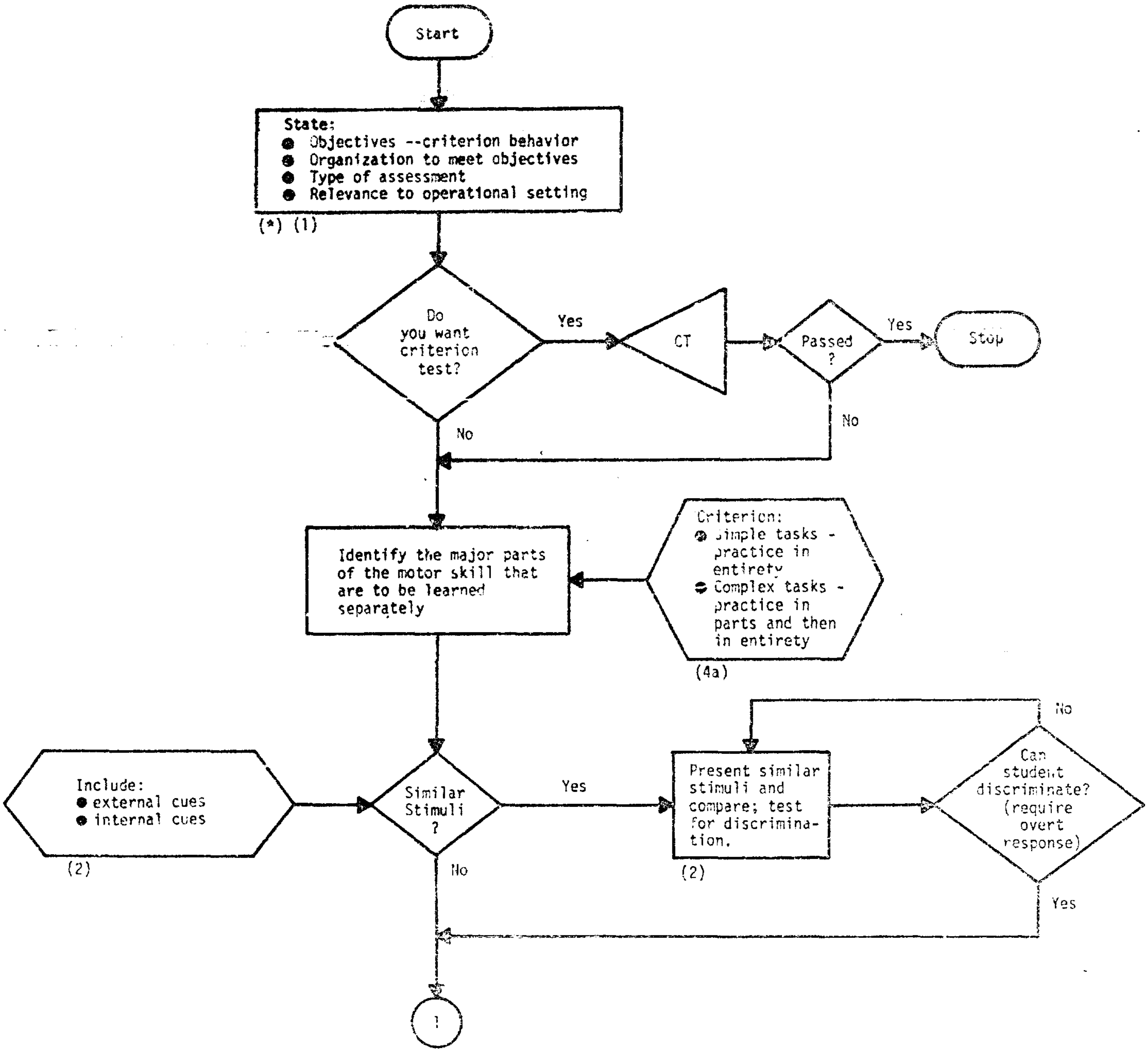
8. Reduce frequency of reinforcement to the operational level as the student approaches criterion performance.

9. Require the student to overlearn desired performance.

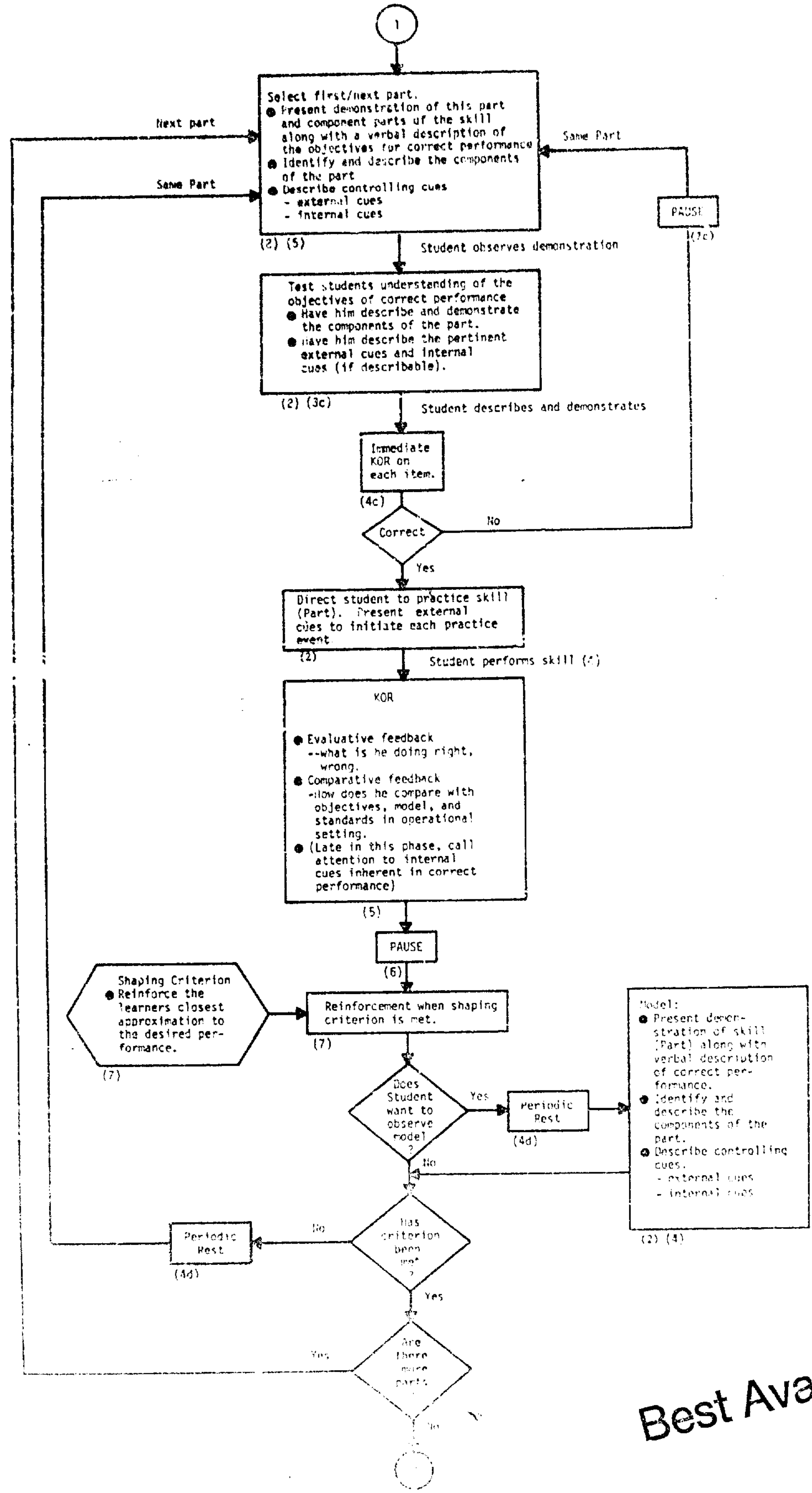
10. Increase distractors towards the end of training to the level

that the person will encounter in the operational setting.

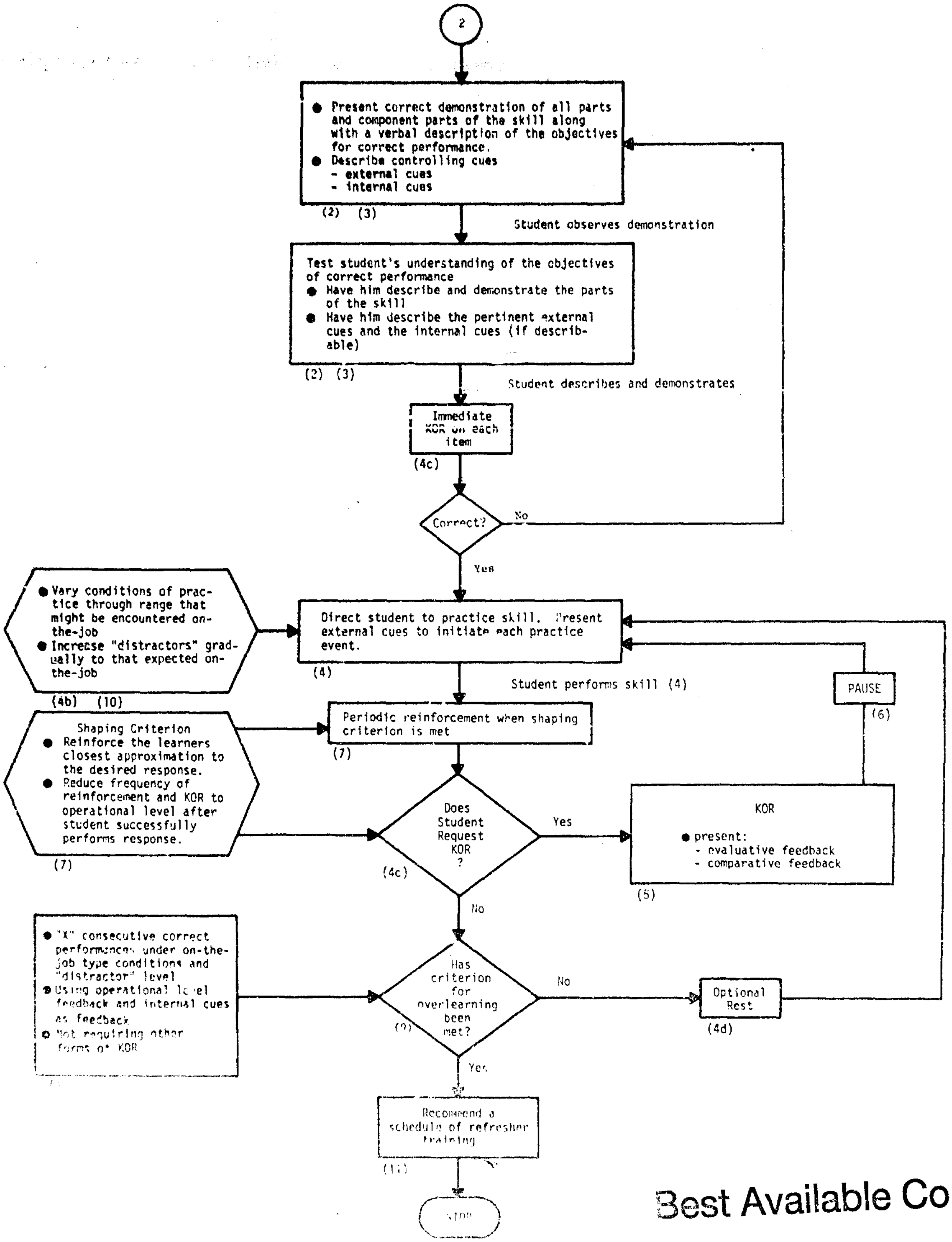
11. Provide for refresher training when the skilled person has not performed the motor skill for an extended period of time.



(*) Corresponds to the guideline number for this task.



1
Select first/next part.
● Present demonstration of this part and component parts of the skill along with a verbal description of the objectives for correct performance
● Identify and describe the components of the part
● Describe controlling cues
- external cues
- internal cues
(2) (5)
Next part
Same Part
Same Part
PAUSE
Student observes demonstration
Test students understanding of the objectives of correct performance
● Have him describe and demonstrate the components of the part.
● Have him describe the pertinent external cues and internal cues (if describable).
(2) (3c)
Student describes and demonstrates
Immediate KOR on each item.
(4c)
Correct
No
Yes
Direct student to practice skill (Part). Present external cues to initiate each practice event
(2)
KOR
● Evaluative feedback --what is he doing right, wrong.
● Comparative feedback -How does he compare with objectives, model, and standards in operational setting.
● (Late in this phase, call attention to internal cues inherent in correct performance)
(5)
PAUSE
(6)
Shaping Criterion
● Reinforce the learners closest approximation to the desired performance.
(7)
Reinforcement when shaping criterion is met.
(7)
Does Student want to observe model ?
Yes
Periodic Rest
(4d)
Model:
● Present demonstration of skill (Part) along with verbal description of correct performance.
● Identify and describe the components of the part.
● Describe controlling cues.
- external cues
- internal cues
(2) (4)
No
Has criterion been met ?
No
Periodic Rest
(4d)
Yes
Are there more parts
Yes
No



Flowchart for Performing Gross Motor Skills (continued)

SECTION III

RECOMMENDATIONS

The learning guidelines and algorithms presented in this report may be used in carrying out the following steps in the design of training systems:

1. <u>Specifying learning events and activities</u>. The guidelines specify the significant learning events and activities that should exist in effective training programs for specific types of tasks. Since there is empirical support for the principles in these guidelines, training system designers should attempt to find practical ways to carry out all of the guidelines.

2. <u>Selecting instructional delivery vehicles</u>. Each type of instructional material is limited as to the functions it can perform. The training system designer should pick an instructional delivery vehicle capable of carrying out the events specified in the guidelines and algorithms. This is contrary to the usual practice where the delivery vehicle is selected first and then the learning events are chosen to be compatible with the delivery vehicle.

3. <u>Designing instructional materials</u>. An instructional delivery vehicle which has the capacity to support specified learning guidelines (see item 2) will only improve learning if the instructional materials to be used in it are also designed to the same guidelines. Therefore, the type, sequence, and relationship of learning events in instructional materials designed for such a system should be in accordance with the appropriate guidelines and algorithms.

4. <u>Evaluating existing instructional materials</u>. It may be more economical to use existing modules of instructional materials than to create new ones. If the modules are to be used in a system designed according to item 2, the guidelines and algorithms should serve as criteria for determining if the modules are suitable or can be modified to bring them up to the required standard.

5. <u>Modifying algorithms to store field experience</u>. When instructional material designed according to an algorithm is shown to be inadequate in the field setting, then the algorithm as well as the instructional material should be modified until the material proves useful for that setting. In this manner, algorithms can be used as the basis for describing the generic structure of successful learning materials for a specific setting and should be used as a specification for the design of similar learning modules.

REFERENCES

Adams, J. A. "Mechanisms of Motor Responsing." In E. A. Bilodeau (Ed.) Acquisition of Skill. New York: Academic Press, 1966, pp. 369-397.

Braby, R. An Evaluation of Ten Techniques for Choosing Instructional Media. TAEG Report No. 8. December 1973. Training Analysis and Evaluation Group, Orlando, FL.

Braby, R., Henry, J. M., Parrish, Jr., W. F., and Swope, W. M. A Technique for Choosing Cost-effective Instructional Delivery Systems. TAEG Report No. 16. April 1975. Training Analysis and Evaluation Group, Orlando, FL.

Braby, R., Micheli, G. S., Morris, C. L., Jr., and Okraski, H. C. Staff Study on Cost and Training Effectiveness of Proposed Training Systems. TAEG Report No. 1. 1972. Training Analysis and Evaluation Group, Orlando, FL.

Bugelski, B. R. An Introduction to the Principles of Psychology. Indianapolis: The Bobbs-Merrill Co. 1973, p. 310.

Cofer, C. N. "Verbal Learning." In M. Marx (Ed.) Learning Processes. New York: MacMillan and Company, Ltd. 1969. pp. 368-369.

English, B. A Student's Dictionary of Psychological Terms. Fourth Edition. New York: Harper and Brothers. 1934.

Ellis, H. C. "Transfer and Retention." In M. Marx (Ed.) Learning Processes. New York: MacMillan and Company, Ltd. 1969. p. 408.

Ellis, H. C. Fundamentals of Human Learning and Cognition. Dubuque, Iowa: William C. Brown Co. 1972. pp. 15, 95, 113, 146, 200, 201, 212.

Gagné, R. M. The Conditions of Learning. New York: Holt, Rinehart, and Winston. 1965. pp. 33-57.

Gagné, R. M. and Briggs, L. J. Principles of Instructional Design. New York: Holt, Rinehart, and Winston. 1974. p. 140.

Glaser, R. Training Research and Education. University of Pittsburg Press. 1962. p. 11.

Hall, J. F. The Psychology of Learning. New York: Lippincott Co. 1966. pp. 134, 529.

REFERENCES (continued)

Hilgard, E. R. and Bower, G. H. Theories of Learning. New York: Appleton, Century, Crofts Co. 1966. pp. 75, 77, 309, 546, 549.

Holland, J. G. "Teaching Machines: An Application of Principles from the Laboratory." In A. A. Lumsdaine and R. Glaser (Eds.) Teaching Machines and Programmed Learning: A Source Book. Washington, DC: National Educational Association. 1960.

Interservice Procedures for Instructional Systems Development, Phase III Develop. NAVEDTRA 106A, 1 August 1975.

Kausler, D. H. Psychology of Verbal Learning and Memory. New York: Academic Press. 1974. p. 195.

Landa, L. N. Algorithmization in Learning and Instruction. Englewood Cliffs, New Jersey: Educational Technology Publications. 1974. pp. 11, 90.

Lumsdaine, A. A. "Educational Technology, Programmed Learning, and Instructional Sciences." In E. R. Hilgard (Ed.) Theories of Learning and Instruction. Chicago: University of Chicago Press. 1964.

Marx, M. "Learning Process." In M. Marx (Ed.) Learning Processes. New York: MacMillan and Company, Ltd. 1969. p. 29.

Miller, N. E. Graphic Communication and the Crisis in Education. Washington, DC: National Educational Association. 1957.

Poulton, B. C. "Tracking Behavior." In E. A. Bilodeau (Ed.) Acquisition of Skill. New York: Academic Press. 1966. pp. 369, 375, 391, 397.

Ruch, F. L. and Zimbardo, P. G. Psychology and Life. Glenview, Illinois: Scott, Foresman, and Co. 1971. pp. 206, 211, 213, 255, 518, 523.

Sheffield, F. D. "Theoretical Considerations in the Learning of Complex Sequential Tasks from Demonstration and Practice." In A. A. Lumsdaine (Ed.) Student Response on Programmed Instruction. Washington, DC: National Academy of Sciences-National Research Council, publication 943. 1961.

Sidorsky, R. C., Houseman, J. F., and Ferguson, D. E. Behavioral and Operational Aspects of Tactical Decision Making in AAW and ASW. NAVTRADEVCEN 1329-1. 1964. Naval Training Device Center, Port Washington, NY.

REFERENCES (continued)

Skinner, B. F. "The Science of Learning and the Art of Teaching." Harvard Educational Review. 1954. 24, pp. 86-94.

Warm, J. S. "Training for Vigilance: Some Suggestions for Research on the Learning, Transfer and Retention, of Watchkeeping Skills." In Learning, Retention, and Transfer. NAVTRADEVCEN 68-C-0215-1, Vol. 2 of 2. February 1971. Naval Training Device Center, Orlando, FL.

Willis, M. P. and Peterson, R. O. Deriving Training Device Implications from Learning Theory Principles. Vols. I and II, NAVTRADEVCEN 784-1 and -2. July 1961. Naval Training Device Center, Port Washington, NY.

GLOSSARY

Affective Reaction - A person's feelings or emotional response to some object or person.

Algorithm (Landa) - A precise, generally comprehensible prescription for carrying out a defined sequence of elementary operation in order to solve any problem belonging to a certain class (or type).

Concept Formation - Classifying objects into groups on the basis of common relationships in their patterns of cues.

Criterion (Cofer) - The degree of mastery to be reached in learning, which is set by the instructor.

Distributed Practice (Ellis) - The introduction of rest intervals during the course of acquisition.

Facilitate (English) - Increased ease of performance, by a
1 - decrease in time
2 - increase of output
3 - decrease in sense of effort;
to make easier or less difficult.

Feedback (Ellis) - Cues that indicate whether a response is correct or not and provides the learner with information about the correctness of his responses.

Guides (Hilgard & Bower) - Environmental cues that facilitate the discovery of the correct response by the learner.

Instructional Delivery System (Braby, et al., 1975) - A system to accomplish human learning made up of the student and all the elements with which he interacts to achieve instructional goals.

KOR (Ruch & Zimbardo) and (Hall) - Knowledge of results--information as to whether the student has responded correctly; information the individual obtains about his actions.

Media - Those materials that store and present information to a student.

Mnemonics (Bugelski) - Memory aids or devices for facilitating the recall of learned material.

Overlearning (Hilgard & Bower) and (Cofer) - Further practice after meeting the initial criterion for learning; continuing to practice beyond the point at which some arbitrary criterion is met. Continuation of practice beyond some criterion of learning (or of mastery).

GLOSSARY (continued)

Positive Reinforcement (Ellis) - Any event that increases the likelihood of a response when it is presented.

Predictability (Poulton) - Quality of being able to predict one event when the other is known.

Prompts (Kausler) and (Glaser) - Stimuli (usually words) known to elicit the response unit when given as a stimulus in a word association test; these elicit implicit associations to that prompt, one of which is the to-be-recalled response unit. A variety of stimulus materials which cue the appropriate behavior.

Proprioceptive Cues - Internal cues from the muscles and tendons indicating their movement and position; cues that are aroused as a result of muscle movements.

Reinforcement (Ellis) - The process by which some response tendency comes to be strengthened.

Salient - Prominent or conspicuous; important, striking, remarkable.

Shaping (Ruch & Zimbardo) and (Marx) - A technique used in training in which all responses that come close to the desired one are rewarded at first, then only the closest approximations, until the desired response is attained; a procedure in which selective reinforcement is used to train the learner by means of successive approximations in some new behavior.

Similar Cues (Ellis) - The number of elements that two cues have in common.

Stress (Ellis) - A state of the organism usually characterized as motivational (and or emotional). The task demands made upon an individual learner.

Vigilance (Warm) and (Adams) - Human watchkeeping or monitoring behavior; observing a display for occasional critical signals; alertness for the detection of critical signals when they occur.