DOCUMENT RESUME

ED 064 622 CG 007 134

AUTHOR Tennyson, Robert D.
TITLE Instructional Model for Concept Acquisition.
PUB DATE 72
NOTE 11p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Concept Formation; Concept Teaching; Conceptual Schemes; *Instruction; *Instructional Design; Instructional Improvement; *Instructional Systems; *Learning; Learning Processes; Thought Processes

ABSTRACT

The purpose of this paper is to demonstrate the feasibility of applying research variables for concept acquisition into a generalized instructional model for teaching concepts. This paper does not present the methodology for the decision/selection stages in designing the actual instruction task, but offers references to other sources which give in-depth procedures. Rather, the purpose is the presentation of the management model rather than the developmental procedures. The instructional model is designed according to conclusions resulting from research studies investigating variables hypothesized to have a direct application to concept teaching. Although the model specifies concept teaching, other types of behavior could use the same sequence, and probably a typical instructional lesson would include various types of behavior. The premises in this paper are that instructional design should be decided by theory as much as possible, and that design components should represent a parsimonious approach to development. (Author/BW)

INSTRUCTIONAL MODEL FOR CONCEPT ACQUISITION

Robert D. Tennyson

Florida State University

A paradigm of instruction for concept acquisition was discussed by Gagne (1970) and empirically investigated by Tennyson, Woolley, and Merrill (1972). Concept acquisition is defined as the ability of the learner to correctly identify previously unencountered objects or events (or representations of such objects or events) as members or nonmembers of a particular concept class. Assumed by Gagne (1970) and Tennyson (1972a) is that for a given learning behavior, an optimal information processing strategy can be identified. By manipulating task variables, such as stimulus similarity, prompting procedures, sequence, and difficulty, an optimal instructional strategy for concept learning can be designed.

Optimal instructional strategy implies that student time and expended effort used to learn a given concept to criterion is minimal. That is, cost in time and effort cannot exceed motivation and reinforcement (either intrinsic or extrinsic), or the learning slows down, or stops all together. Effectiveness, in terms of amount learned and retained, combines with efficiency in this assumption of an optimal system.

Instructional Model

The payoff of educational research is the application of the findings in an applied instructional environment. The purpose of this paper is to demonstrate the feasibility of applying research variables for concept acquisition into a generalized instructional model for teaching concepts. This paper does not present the methodology for the decision/selection stages in designing the actual instruction task; other sources give in-depth procedures (Tennyson, 1972a; 1972b). The purpose here is the presentation of the management model rather than the developmental procedures. The instructional model (Figure 1) is designed according to conclusions resulting from research studies investigating variables hypothesized to have a direct application to concept teaching.

Insert Figure 1 about here

1. Pretest. The first component of the instructional model is a pretest on the concept class to be taught which assesses the student's entering behavior. The criterion referenced testing evaluates minimum capabilities. If the student meets criterion, he advances to step five, classification test; if not, he proceeds with step two, definition.

2. Definition. In the study by Merrill and Tennyson (1972) on prompting effects, it was found that subjects performed significantly better on the l arning task when given the definition which identified the relevant attributes of the concept class. Without the definition the subjects became confused. The definition is a statement identifying the relevant attributes shared by a set of instances in a given class. Relevant attributes are enabling or prerequisite concepts assumed to be known by the student. Writing the definition requires a thorough analysis of the concept, usually resulting in simplification and reconceptualization of the class.

3. Review. Merrill and Tennyson (1972) included a treatment condition which presented the prerequisite subskills of the concept being taught. The results did not indicate that this variable was a significant factor in task performance. However, certain blocking schemes of the data showed that subjects with low pretest scores receiving a review did better on the posttest than similar subjects not receiving the review. The re-

view component is included as a student option. In computer controlled courses students with low aptitude profiles could be advised to take the review. Whatever the mode of control, students should make the basic decision (see Bunderson, 1971, for a review on learner control).

4. Instructional task. Tennyson, Woolley, and Merrill (1972) developed an optimal group instructional strategy for teaching concepts based on the theoretical work of Mechner (1965) and Markle and Tiemann (1969, 1970) For concept acquisition, an optimal information processing strategy consists of presenting examples and nonexamples to the student in such a way that the relevant attributes are clearly contrasted with irrelevant attributes. Task variables affecting student's processing of this information can be determined by four categories of procedures which are identified as stimulus similarity variables, prompting/feedback variables, sequence variables, and instance difficulty.

A. Stimulus similarity variables include the following:

1) Matching of examples with nonexamples. An example is matched to a nonexample when both share identical or very similar irrelevant attributes.

2) Divergent examples. An example is divergent from another example when the corresponding irrelevant attributes are different. Examples which share the same irrelevant attributes are said to be convergent.

B. Prompting variables include the following:

1) Presenting a definition which identifies the relevant attributes (step 2 of the model).

2) Using various devices to identify the relevant attributes imbedded in exemplars.

3) Explaining why a nonexample is not an example.

C. Sequence variables include the following:

1) Simultaneous presentation of instances.

2) Instructor selected sequence.

D. Difficulty of instances.

These four task variables are manipulated into an example set (Figure 2).

Insert Figure 2 about here

According to the concept paradigm, two examples should be paired (divergent) so that they differ as much as possible in their irrelevant attributes. Within the same simultaneous presentation, two nonexamples are presented which are matched to their respective examples by having irrelevant attributes as similar as possible. This relationship of examples and nonexamples is designed to focus the student's attention on the relevant attributes. In the investigation by Tennyson (1972b) on the effect of nonexamples in acquisition, it was shown that subjects not receiving nonexamples responded randomly on the posttest, while subjects receiving nonexamples responded as hypothesized.

Prompting is used in the example sets to explain why an instance is an example or why it is not an example. The subject matter determines the type and amount of prompting necessary. Example sets range in difficulty from easy to hard. Depending on the adaptability of the program and the hardware, the instructional sequence could have multiple entry points and student control over exit. Entry could be determined by student profile data to individualize on trait and state variables.

5. <u>Classification test</u>. Tennyson et al. (1972) designed a posttest which was capable of determining the degree and type of classification

error the student was making at the conclusion of the instructional task. The test examined the student's scoring patterns four different ways to see if he had an overgeneralization, an undergeneralization, or a misconception of the concept class (cf. Markle and Tiemann, 1970). Construction of the classification test follows the same procedures as outlined for the instructional task. The task presentation is expository, that is, the student is told whether an instance is positive or negative; while the classification test is inquisitive, that is, the student is not told the nature of the instances. Feedback is given on the correctness of the answer, however, no prompting is given a wrong answer. Students meeting criterion on this test are finished with the lesson. Students not passing the classification test proceed to the next component where they receive remedial instruction based upon the type of classification error they made on the test.

6. Adaptive sequence. Concepts which are simple would require only specific review if a student fails the classification test. For concepts that are complex it is possible to identify student error if criterion is not met (Tennyson et al., 1972; Tennyson, 1972a). Two basic levels of adaptation are possible, general and specific. In the general adaptive sequence students would be classified into one of the three error categories. For each category an optimal group instructional task is given to correct the error. For example, if a subject overgeneralizes, a specific program designed to correct that classification error would be given. The corrective programs would be:

A. Overgeneralization. For students who overgeneralize, the general adaptive procedure would be to select instances of easier difficulty than normally would be used in a standard example set sequence used in the instructional task. Also, an increased level of prompting is given for each instance.

B. Undergeneralization. This error indicates that the student failed to identify difficult examples. T` cor- rect this, the example sets would begin with harder instances than used in the instructional task. The sequence would basically concentrate on difficult example sets. Prompting would increase slightly.

C. Misconception. Since the subject seems to be focusing on some irrelevant attribute, the divergency of the examples would be expanded so that common irrelevant attributes are practically eliminated.

In all three corrective programs the students with each error category would receive the same modified sequence.

Specific adaptive is similar to the general adaptive condition in that adaptation is made according to type of error, but the corrective procedures also are individualized according to the degree of error. The degree of error is determined by the number of errors of a given type. A student who makes many overgeneralization errors would be given easier instances than a subject who makes few overgeneralization errors. The specific adaptive sequence also would increase prompting in a controlled situation so that no student is either overloaded or insufficiently instructed.

7. Adaptive test. This test is designed to evaluate the effect of the corrective sequence. Test items would reflect the type of error to be corrected. It would not be a comprehensive test unless that degree of error was committed. Passing this test would exit the student from

the program. Failing again, the student would receive one further level of remedial instruction.

8. Specific review. This form of correction has a long history in the field of programed instruction. Remediation is specific to the item missed. Again the degree of the problem determines amount of corrective review. Concluding this component of instruction a final test is given.

9. Review test. A standardized test similar to the classification test is given. A student failing to this point indicates that he learned almost nothing from the instructional task. In such a case this review test again assesses his behavior to perform at criterion. If the student meets criterion, he exits; if not, a continuation in the course is decided.

10. Advisement. In complex courses it is possible that some students would have difficulty with certain concept lessons. In such situations, two decisions can be made: the student drops the course; or, continues with the next lesson and reschedules this lesson for a later date. The student's individual cumulative profile is a major factor in the decision process (Bunderson, 1971).

Summary

The instructional model for concept acquisition was designed according to theoretical assumptions supported by empirical research data. The model allows for flexibility and modification by the individual user developing courseware for application in educational settings. Although the model specifies concept teaching, other types of behavior could use the same sequence, and probably a typical instructional lesson would include various types of behavior. In such situations research-based variables are available to adjust the model. In instuctional projects where various behavicrs are used, this model might be a subunit or a larger management model. The premises here are that instructional design should be decided by theory as much as possible, and that design components should represent a parsimonious approach to development.

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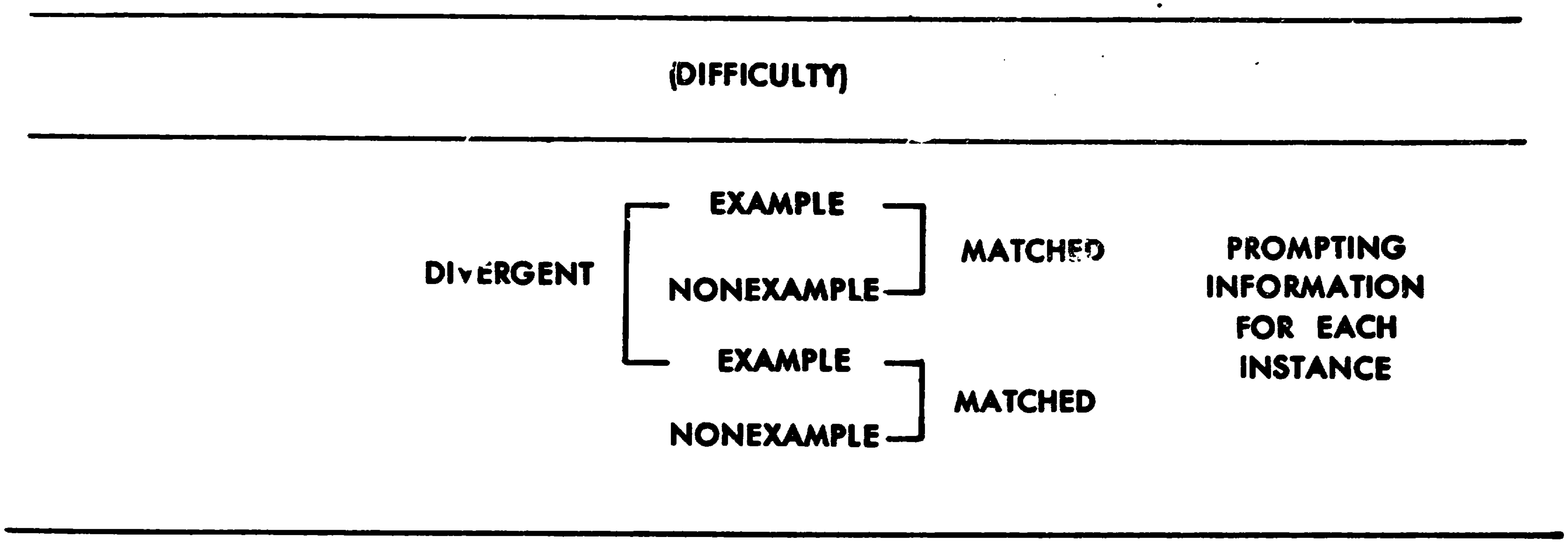

FIGURE 2. RELATIONSHIP OF EXAMPLES AND NONEXAMPLES IN CONCEPT ACQUISITION.

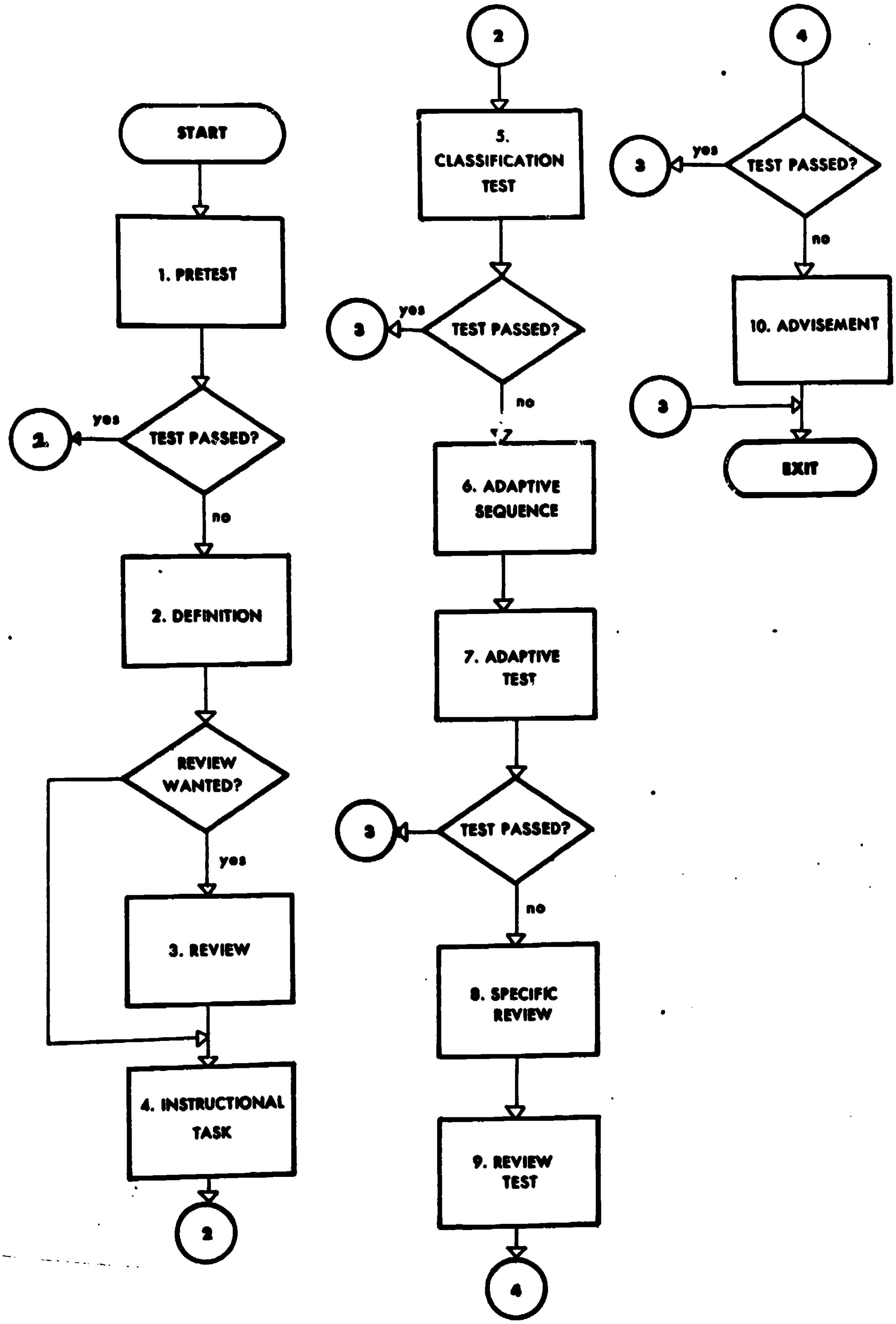

Figure 1. Instructional Model for Concept Acquisition.