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ABSTRACT

The placement and diagnostic tests used in instructional systems designed to be adaptive to the individual learner's characteristics are examined. The necessity of pretesting students before instruction is questioned. According to the author, both the necessity for and the content of the Individually Prescribed Instruction (IPI) type of pretest should be more carefully examined. While the diagnosis of errors is viewed positively, the need to prescribe specific instruction for every type of error is doubted. The importance of analyzing the psychological structure of a specifc course, thereby determining the sequence of tasks necessary in order to facilitate later learning, is stressed. Examples of various types of placement and prescriptive procedures, including Individually Prescribed Instruction and adaptive testing are presented. (Author/MV)

Assessing Students for Prescriptive and Placement Purposes

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A paper presented at the Sixty-first Annual Education Conference, "Evaluation In the Schools", Iowa City, Iowa, December 7-8, 1976.

ABSTRACT

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This paper examines the use of placement and diagnostic tests in systems of instruction designed to be adaptive to the characteristics of learners. The procedure of always pretesting before instruction is called into question. It is argued that both the necessity and the content of the IPI -- type of pretest should be more carefully examined before this pretesting paradigm is widely adopted. "Diagnosing errors" is viewed positively, but the necessity of prescribing specific instruction for every type of error is questioned. Examples of a variety of types of placement and prescriptive assessment procedures are given. The importance of analyzing the instructional context and the kinds of instructional decisions to be made is stressed.

Assessing Students for Prescriptive and Placement Purposes[1]

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Let's assume that an individualized course of instruction has been designed and that it has the following characteristics:

1. The terminal objectives and goals of the course have been specified. Further, these goals have been translated into defined domains of tasks, so that the student's performance on the tasks will form the basis for inferring that the student has attained the course goals.
2. A sequence of intermediate learning objectives that leads to the attainment of the terminal outcomes has been arranged.
3. Various alternative instructional procedures have been developed for each of these intermediate and terminal instructional goals.

Now consider how students might most efficiently make their way through such a course. Where should each begin? What instructional procedures should each follow? How will students know when they are finished? These three questions correspond to decisions about placement, diagnosis, and attainment (Glaser and Nitko, 1971). (See Figures 1 and 2.)

A placement decision answers the question, "Where in the instructional sequence should the learner start in order to avoid repeating unnecessarily what is already known and in order to encounter readily attainable new goals?" The tests that give the information needed to

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make this decision must be derived from an analysis of the psychological structure of the specific course. Discovering the psychological structure of the course means to find the processes of transfer and generalization that make it possible to order behaviors in a sequence of prerequisite tasks so that competence in an earlier task in the sequence facilitates the learning of later tasks in the sequence (Glaser and Nitko, 1971, p. 636). Tasks can be operationally defined as domains of test items.

Placing a student in a curriculum does not necessarily specify the methods of instruction that should be used with a particular student. Tests that give information about the nature of the instruction to be used might be called diagnostic tests. Diagnostic decisions answer the question, "What learning activities will best adapt to this student's individual requirements and thus maximize his attainment of the chosen goal?" This distinction between placement testing and diagnostic testing is not conventional. Customary diagnostic tests involve both placement and diagnosis.

The art of distinct diagnostic testing is not yet well developed. Two directions have been attempted. One direction is closely related to aptitude-treatment-interaction research (see, e.g., Cronbach and Snow, 1969; Glaser, 1972; Glaser and Nitko, 1971). This line of research seeks to discover pupil characteristics that interact with methods of instruction in such a way that it would be possible to optimally assign different pupils to different methods of instruction to learn the same thing. No tests now exist that accomplish this purpose of differntial assignment to learning school subjects in a way that is psychometrically acceptable to aptitude-treatment-interaction researchers.

A second direction for diagnostic testing involves fine-grain analysis of an individual pupil's performance domain. What microscopic prerequisite skills are strong or weak? What misinformation or inappropriate associations may interfere with certain activities? Tests can be designed to answer questions such as these.

When instruction has been completed, interest centers around whether the student has learned the terminal objectives. Verbal statements of terminal objectives usually imply that an individual ought to be able to perform quite a large number of tasks. This is particularly true when generalization and transfer of learning are of primary importance. Decisions that center around whether terminal objectives have been learned can be called attainment decisions.

An Example of Testing and Decision-Making

Having sketched out some of the basic decisions to be made in instruction, let us consider an illustration of how testing and decision-making have been integrated. The example comes from the Individually Prescribed Instruction (IPI) Project's elementary mathematics curriculum (Lindvall and Bolvin, 1967).

Figure 3 schematically represents the IPI mathematics curriculum. The content of this curriculum area has been broken down into 10 topics which are roughly in a prerequisite order (from top to bottom in the figure). Further, each topic can be learned at different levels of complexity. These are also in a rough prerequisite order (from Level A through Level G in the figure). Each cell in the grid represents several instructional objectives and is called a unit of instruction. The inset shows (hypothetically) how a short sequence of objectives might be ordered in a learning hierarchy for one unit. Each box in the hierarchy represents one objective. Usually, the hierarchy leads to a few terminal objectives (boxes "I" and "J" in the inset). Each usually draws on prerequisites from earlier topics and lower levels. (These are shown below the dotted line in the inset.)

Table 1 gives examples of some of the kinds of placement, diagnostic, and attainment information that would be useful for making instructional decisions in the IPI curriculum.

Figure 4 shows a flow chart of how testing and instruction blend together to guide the flow and content of instruction for each individual student. This system is not as elaborate as the system of placement, diagnosis, and attainment testing previously described, however.

Placement Testing

Let us consider the problem of how to place pupils in a curriculum sequence like that shown earlier in Figure 3. To answer the question, "Where in the instructional sequence should this pupil begin?" the decision-maker would need information about how well the student had mastered each topic and where within a unit the student should begin learning.

This is accomplished in the IPI procedure by two-stage testing (Cox and Boston, 1967). The first stage test is broad-ranged over the entire curriculum. These test results are used to place a student at a unit in each topic or content area. This first-stage would provide a profile for the student like the one shown in Figure 5. This profile shows, for example, that the student could begin studying in the unit at the D-Level of division.

The second-stage test is narrow-ranged and tests only the domain of behaviors implied by a single unit. In this example, the second-stage test would test the content of D-Level division. The results of such a second-stage test would be used to place a student at a particular objective within a unit. The first-stage test would need to be administered only once, at the beginning of the course of study. After completing instruction on the first unit of study, here it is D-division, the student would be given the second-stage test for the next sequential unit of study (D-Fractions). In this way, the student would be placed at each successive unit in the curriculum. Figure 6 shows what a completed second stage placement profile might look like.

The second-stage test is called a <u>pretest</u> in the IPI testing scheme. This pretest requires a student to be tested on all of the objectives in a unit in order to make a placement decision. Since a single item provides an unreliable basis on which to make a placement decision with respect to an objective, the pretest contains several subtests. Each subtest covers one objective with approximately 8 to 10 test items. If a unit of instruction had 15 objectives, for example, a student would have to take 15 subtests (or approximately 15 x 8 = 120 items) before a placement decision could be made. Such a testing scheme is non-adaptive and time-consuming. (It should be noted, however, that the size of a unit of instruction is arbitrary and based on considerations, such as student motivation and practical matters, such as the amount of available instructional time.)

In an effort to better adapt placement testing to the individual learner, Ferguson (1970) and others (Ferguson and Hsu, 1971; Hsu and Carlson, 1972) have explored the use of the computer as a test administrator and decision-maker. Each student would take second-stage placement tests sitting at a computer terminal. The trick here is to make a decision about every objective in the hierarchy of the unit and obtain a profile like the one shown in Figure 6, <u>but</u> to obtain this profile <u>without actually</u> testing every objective. Their procedure also allows the completer to decide how many test items to administer to each child for any particular objective to be tested. For example, some children may need to take only four items before a reliable decision could be made, while other children may need to be administered as many as 20 items before the same type of decision could be made.

When placement testing in this way, a set of decision rules is devised that combines the capabilities of the computer with both statistical logic and subject-matter logic. This allows a dynamic process to occur to decide what is to be tested and how extensively it is to be tested. This procedure breaks away from the traditional "test now, decide later" schemes that have received recent criticism (e.g., Green, 1969).

As an illustration consider the hierarchy sketched in Figure 7. If the objectives can be organized into a hierarchy, the psychological structure can be employed as part of the decision-making procedure. This consideration results in what can be called a <u>branching rule</u>--that is, a rule programmed into the computer for <u>determining</u> the <u>next</u> objective to be tested. Choice of the next objective on which a student is to be tested depends on whether the student was declared a master or a non-master on the last objective <u>and</u> on the student's response pattern that led to the decision.

For example, consider Figure 8. The testing began on an objective in the middle of the hierarchy. If a student is declared a master on this objective, the student is assumed to have also mastered all of the objectives below this place in the hierarchy. Which of the objectives above this point the student has mastered would need to be determined. If this student had a real high score on this test, he could be called a "high master" and branched all the way to the top of the hierarchy for testing next. On the other hand, a student having a lower passing score might be called a "low master" and branched for testing next some where half way between the middle and the top of the hierarchy. Similar branching patterns could be applied to "low" and "high" non-masters. A few applications of these branching rules would locate students quickly and efficiently in the hierarchy and would not require them to be tested on everything whether they needed it or not before a placement decision could be made.

It should be noted that in order to use the computer to perform large-scale testing for an entire curriculum, it is necessary to have the computer actually generate the test items. Large-scale, practical programs of this kind have not yet been developed and evidence concerning the appropriateness of the procedure needs to be provided before it can be strongly recommended. For example, if a unit of instruction has only a few objectives then a computer-testing scheme is more elaborate than needed. Also, if a unit cannot be organized into a neat Gagné-type of hierarchy such as that which has been described here, then branching rules cannot be applied.

Diagnostic Testing

In diagnostic testing we seek to determine the kind or nature of the instruction that we ought to give to the learner in order to facilitate learning. Of the two methods of testing described earlier--aptitude-treatment-interaction and analysis of an individual's performance domain--only the latter will be discussed here.

The practical problem is this: Sometimes the pre-arranged instructional materials in an instructional program, for which a system of placement and attainment tests has been designed already, do not effectively teach an individual student. This student needs a special prescription based on available alternative materials. One basic piece of information that is easily overlooked in classroom situations is a formal cataloguing of available alternative materials for instruction. It is of no use to attempt to develop a prescription for learning a particular arithmetic concept, for example, by using manipulative exercises if such exercises could not be made available.

An example of a very specific procedure for providing information concerning what types of learning materials are available for teaching each instructional objective in a unit of study in a mathematics program is shown in Table 2. This form links test information with instructional resources and can be used as a prescription form. It can be seen that space is provided for the pretest or placement test score on each of five objectives (A, B, C, D, and E) in this unit. This is followed by a listing of lesson materials available for use in studying each objective. For example, there are three sets of manipulative lessons (manip.), one game, and one workbook available for Objective A. Also, the form provides space for indicating which materials a pupil is to use, when each lesson is completed, and a space for recording attainment test results for each objective. This form, of course, would not have applications to programs that are not structured or for which the materials listed are not available in the classroom.

It should be noted also that with such a form, a teacher or a school system could build-up a large data-base concerning which types of instructional materials worked best with specific kinds of students. Such information might then be recorded in a teacher's "clinical handbook" that could be generally available for reference.

One type of diagnostic testing has been used in a computer-assisted testing project at the Learning Research and Development Center in the area of elementary school arithmetic (Hsu and Carlson, 1972). In this project each single instructional objective was broken down into finergrained clusters of tasks (items). Each cluster of items consisted of very highly similar types of items so that each item within a cluster of items tended to elicit a particular type of error if not answered correctly. For example, if an objective was "Multiply a two-digit number by another two-digit number using a multiplication algorithm", then this would imply 8,100 problems. Aspects of these problems such as carrying or noncarrying, how large the carry, the place from which the carry occurred, or the appearance of zero in the factors, all could serve to define specific clusters of items. Within specific clusters, common types of errors might appear. Three of the many types of clusters that could be formed for this example are shown in Table 3.

This type of diagnostic testing has been integrated into a computer-assisted placement testing scheme like the one mentioned earlier (Hsu and Carlson, 1972). When this is done, and if an objective is not mastered, the computer can print out a description of the clusters of items with which the student had difficulty as well as the student's score on the objective. Using procedures whereby each teacher could have access to a handbook that listed instructional materials and/or procedures that have been found helpful to teach pupils to overcome these errors, the teacher would be in a position to tailor instruction to the individual learner.

In a complex computer-assisted testing program, the teachers' handbook could also be stored in the computer's memory and after the pupil is placed, the computer could also print out the instructional options available to the teacher and learner. An example of what such a print out might look like is shown in Figure 9.

But one does not need to have a computer administer and score a test in order to obtain this type of diagnostic information. In Florida's Dade County Public School System, multiple choice tests were developed (Nesbit, 1966). Each foil of the multiple-choice items were based on common-errors students have made in the past. Each of these error-types were identified for the teacher in a type of diagnostic error catalogue and remedial activities that other teachers had found helpful were also listed. Figure 10 illustrates this procedure. Cataloguing types of errors and the learning activities that have been effective to remediate these errors is one way that all teachers might have access to the successful clinical prescriptions of the master teacher.

Further refinements of this type of fine-grained analysis of a pupil's behavior can be made either with the computer (Binstock, Pingel, and Hsu, 1975) or by the teacher. One of these refinements is to examine the process by which students who are having difficulty respond to tasks. Each step of the solution to an arithmetic problem can be examined and the student can be asked what the response at that step should be. If a human is present, the student can be asked why he or she made the response. Oftentimes, these interviews with students reveal mistaken conceptions held by the student that would have not otherwise have been identified.

Necessary and Sufficient*

At this point we might ask, "Is all of this placement and diagnostic testing necessary? And, is it sufficient? That is, do we need other testing?"

First of all, whether one needs the type of placement testing previously described depends on the instructional program available and of the consequences of testing or not testing. If the instructional sequence is not ordered in at least a rough prerequisite order and if the instructional sequence cannot accomodate a pupil who, say, has learned half of the course content but not all of it, then placement testing cannot be very useful. Even if we had placement information we could not use it if the instructional system does not accommodate individual differences in competence. Further, even in circumstances where individual differences can be accommodated, the pretest approach of IPI Mathematics might be wasteful of pupil time. Let's briefly examine this.

Recall that in IPI Mathematics the pupil was given a pretest on each instructional unit of the curriculum (see Figure 4). Every time a pupil took a pre-test, the pupil was tested on every objective in the unit. Perhaps there were from 60 to 100 items on this pre-test. We have to ask whether this much testing is really necessary and useful. For example, it may be that a child takes two or three class periods to complete such a pre-test and after completing the test the child would need three or four more class periods of instruction. Total pre-testing time plus instruction time may be five to seven class periods. It might be entirely more effi-

*Grateful acknowledgement is made to Dr. Isabel Beck of the Learning Research and Development Center, University of Pittsburgh, for providing information to me on the New Primary Grades Reading System and for stimulating many of the ideas presented in this section.

cient to have all children take instruction for each unit of the curriculum instead of checking to see if some few children could test out of instruction. Eliminating unnecessary pre-testing would reduce the amount of time a child would have to spend in a unit from say five to seven periods to three or four periods.

But what about the first-stage placement test, the one in IPI Mathematics that located the level of the pupil in the curriculum. We have already stated that once a pupil is in the curriculum sequence, further testing with this first-stage test would be unnecessary because we already have the instructional history of the student at our disposal. So, the first-stage placement test is useful only for those pupils for whom we have little or no information about curricular history.

There are other considerations here, however, beside just location in a specific curriculum. This is especially true in subject areas outside of arithmetic. In reading for example, pupils transferring into a school system from another system often have been instructed using a different reading series. In this instance we need to know the answer to two questions before we can place and instruct the child. We need to know the general reading level. (For example, we would like to know whether the child can be put into the middle group of the second grade.) But also, we need to know whether the particular idiosyncratic connections, content sequence, and so on of the reading series we are using have been learned by the pupil. If not, then even if we place the pupil at the proper reading level, the pupil will have difficulty learning from the type of instruction that we have to offer. The IPI

Mathematics type of placement testing procedure does not test for this acquisition of the idiosyncracies of a particular curriculum. An analogy might help to clarify the point. We hire someone to perform a job on the basis of information about the person's general level of skill and knowledge. After we hire the person, we give on-the-job-training to acquaint the person with the idiosyncracies of the job that were not acquired before being hired. Similarly, if we know a pupil's general reading level we can place the pupil in the reading program, but what we often lack is information about the kind of on-the-job-training the pupil needs to quickly acquire more advanced learning.

And what about these diagnostic testing procedures? Are they necessary and sufficient? In a truly adaptive and personalized instructional system, diagnosis for student learning difficulties will be a continuous, on-going process. The super teacher will obtain this information from interacting with the child around the daily instructional materials. But not all teachers are able to do this in an exceptional way.

The diagnostic tests we have discussed today do little to look at process. That is, <u>how</u> the learner performs the skill. Further, they do not assign differential importance to the categories of errors detected. They simply identify errors.

Errors in learning are often in need of interpretation in light of the particular instructional program in which they occur. In some instructional sequences, for example, a highly proficient level of performance is required in order to continue. In other programs, however, instruction is so designed that it is spiral in nature. When this occurs, it is often necessary only to have a very minimal level of proficiency in order to proceed to new instruction because the concept or skill to be learned will be taught again and integrated into more advanced learnings. For example, those who have studied statistical methods may recall the standard deviation. The meaning and value of the standard deviation as a statistical index and concept is one of the most difficult to understand for the beginning student. It is only after advanced statistical topics are studied and after one uses the standard deviation in practical problems, that one is able to come to "see what it means". Had the instructor insisted on complete mastery of this concept before proceeding to new material, then students would have been in great difficulty and perhaps would not have learned the concept at all.

Similar instances occur in other subjects. In reading, for example, one program that illustrates this point is called the New Primary Grades Reading System (Beck and Mitroff, 1972) and is being developed currently at the Learning Research and Development Center. The spiraling nature of the curriculum can be described in this way (Beck, 1975):

> In a spiraling structure, the child initially learns to decode on a limited number of important [letter/sound] correspondences;

> then many sentences and "story paragraphs" containing words with those decodable elements are made available to [the child] in connected text. As the child reads with meaning through the known elements, the next loop in the spiral enlarges [and the child] is introduced to new elements. The child continues to read extended meaningful texts that incorporate the new elements with previously taught content. (pp. 21-22)

This curriculum is unlike the strict hierarchial structure implied by IPI Mathematics, where in each prerequisite would need to be learned at a relatively high level of proficiency before moving to more advanced learning. As a consequence of the spiral nature, it is possible to identify which specific learnings are important to acquire at a high degree of <u>initial</u> proficiency and which learnings need only a minimum initial level of proficiency because the child will encounter and practice these learnings later in the curriculum. Also, by examining the relationship between the learning materials, the curricular sequence and the types of errors, it is possible to determine which pupil performance errors are serious and which are not serious. Errors that are not serious could either be remedied by a few instructional comments by the teacher or ignored entirely. Thus, no formal remedial prescription need be written and valuable instructional time on new content need not be lost.

A little bit of insight into this type of carefully designed program can be obtained from Figure 11. Instructional materials and resources are carefully correlated to the child's workbook. This is important in this system because each child will be reading at a different level and the teacher will need to have readily available information about each lesson as the teacher "travels" or moves from child to child for tutoring. Here we will focus on the prescription and the diagnosis aspects.

Within the child's workbook is a prescription form that lists the available instructional materials for the specific lesson at hand. This allows the teacher the opportunity to tailor the assignments to the pupils. In addition, the prescription form shows the child what are some of the other options available. These include games and read-along books. Each prescription form "advertises" these options to the child. Prescription then includes not only what the teacher assigns but also what the child would like to do. An example of a prescription form is shown in Figure 12.

Diagnosis occurs at two levels--during the lesson and at the completion of the lesson. At the bottom of some of the workbook pages are notes to the teacher that suggest specific kinds of interaction between teacher and pupil with the instructional materials (see Figure 11). These interactions provide opportunities for detection and immediate correction of learning difficulties.

At certain points in the workbook short tests called progress checks test formal mastery of key elements of content. The child's responses to the tasks on these short tests are analyzed for possible errors. Errors are not only classified as to type, but the teacher's guide indicates whether the error is serious enough to delay advanced instruction. Some errors are serious and the teacher has available a book of alternative ways to teach the content since the mainstream instructional materials weren't effective. Other errors are less serious and minor attention may be needed. These types of errors are often self-correcting on the part of the learner because of the spiraling nature of the curriculum. An illustration of this type of diagnostic procedure is shown in Figure 13.

This example is from an early level of the reading system and shows attention to the processes the child uses in decoding the printed words.

Summary

In summary then, testing palys a role in systems of instruction that are designed to adapt to the characteristics of learners. One characteristic is the learner's past level of general knowledge of the subject or skills we would like to teach. Tests which provide information that allow the decision to be made about where in the instructional sequence the learner is to begin in order to avoid repeating unnecessarily what is already learned and in order to encounter readily attainable new goals, can be called placement tests. We have examined the IPI Mathematics two-stage placement procedure as an example of a placement test in an adaptive system. Further, we argued that such placement tests as these may not be entirely necessary and that they may not be sufficient. To be necessary, we have to answer another question, namely, "What consequences would result if we used the placement test or if we didn't use the placement test?". Sometimes instruction plus testing takes longer than instruction alone and thus testing might be considered unnecessary. Other criteria might be considered also before a judgment about necessity would be made. To be sufficient one would have to answer the question, "What other kinds of information would be needed before a placement decision can be made?" Here we argued that it is often useful to know which of the program specific or program idiosyncratic conventions and learning methods does the student know before we could place the pupil. Some pupils may, for example, read at the proper grade level, but they might need some on-the-job-training to learn how to learn from the instructional system they will use in their new school.

A second characteristic to be examined is the nature of the learning activities that best fit an individual's requirements and thus maximize the individual's chance of attaining the chosen goal. Tests giving some of this kind of information can be called diagnostic. Computer-assisted testing and the Dade County arithmetic tests were used as examples. The key to both of these tests was their ability to identify pupil errors and match these errors with specific remedial instructional activities. However, both of these tended to give little attention to the processes by which the pupil responded to the learning material and tended to weigh all errors with equal seriousness. Another example was considered, one from the New Primary Grades Reading System. In this system not only are errors classified and linked to instructional activities, but they are viewed in the context of the particular type of instructional system in which the child is learning. That is, the spiral nature of the learning sequence is taken into account so that not all errors are viewed as being of equal seriousness nor do they all require elaborate remedial teaching. Some errors can be ignored since they would be expected to be overcome as the child progresses to new learning experiences.

In all of this, then, the context of the instructional program shapes the kinds of placement and diagnostic information that is required and, therefore, the types of tests that would be useful. Without an analysis of the kinds of instructional decisions to be made in a given situation, discussions about tests and testing procedures tend to be fruitless.

Not only does the test information need to be useful, but the information should be <u>useable</u> as well. That is, testing should be designed into the instruction process so that the information that is required can be obtained easily and is available in a form that is useable when a decision needs to be made.

When viewed in this way; the distinction between testing and instruction becomes less distinct. The learner can look toward testing as feedback about accomplishments and for guidance toward chosen goals.

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THREE KINDS OF DECISIONS

Types of Decisions	Questions Asked
I. Placement Decisions	"Where in this curricular sequence should this pupil be located to begin instruction?"
II. Diagnostic Decisions	"What are the characteristics of the instruction that should be given this student so that the student will be able to master the skill(s) for which the student was placed?"
III. Attainment Decisions	"Has the student acquired the skill(s) on which instruction has been given?"

Figure 1

CHARACTERISTICS OF AN INDIVIDUALIZED COURSE OF INSTRUCTION

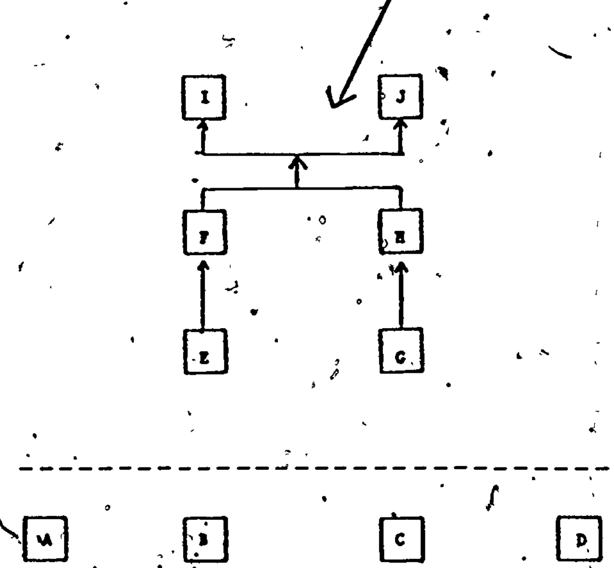
1. Terminal objectives and goals have been specified and translated into task domains.

2. Sequence of intermediate learning objectives has been arranged.

3. Alternative instructional procedures have been developed for each instructional goal.

Figure 2

Content (Topic)	Level of Complexity						
	A	B	C	D	E	F	G
Numeration/Place Value	*	*	*	*	*	*	*
Addition/Subtraction	*	*	*	*	*	*	*
Multiplication		*	*	*	*	*	*
Division		*	*	*	*	*	*
Fractions	*	*	*	*	*	*	*
Money	*	*	*	*			
Time	*	*	*	*	*		
Systems of Measurement		*	*	*	*	*	*
Geometry		*	*	*	*	*	*
Applications		*	*	*	*	*	*



*Indicates a unit of instruction consisting of one or more instructional objectives.

Figure 3

Example of curriculum layout for Individually Prescribed Instruction elementary mathematics

Pupil Information Requirements
in Adaptive Individualized
Instruction

I. Placement Information

--"Where should this pupil be located in the curricular sequence to begin his instruction?"

Example: Johnny should begin his studies at C-Level Addition, Skill 4.

II. Diagnostic Information

--"What are the characteristics of the instruction that should be given this student so that he will be able to master the skill at which he was placed?"

Examples: Sue should review those C-Level skills related to regrouping before studying D-Level Subtraction, Skill 4.

Johnny regroups from hundreds to tens but does not change the hundreds digit accordingly. Review regrouping skills.

III. Evaluative Information

--"Has the student acquired the skill(s) on which he has been instructed?"

Examples: Jim has demonstrated mastery of D-Level Addition, Skill 5 by getting $\geq$ 85 per cent of the items on the CET correct.

Johnny has scored at or beyond the criterion level for all skills in the C Subtraction unit, except for Skill 3.

Table 1

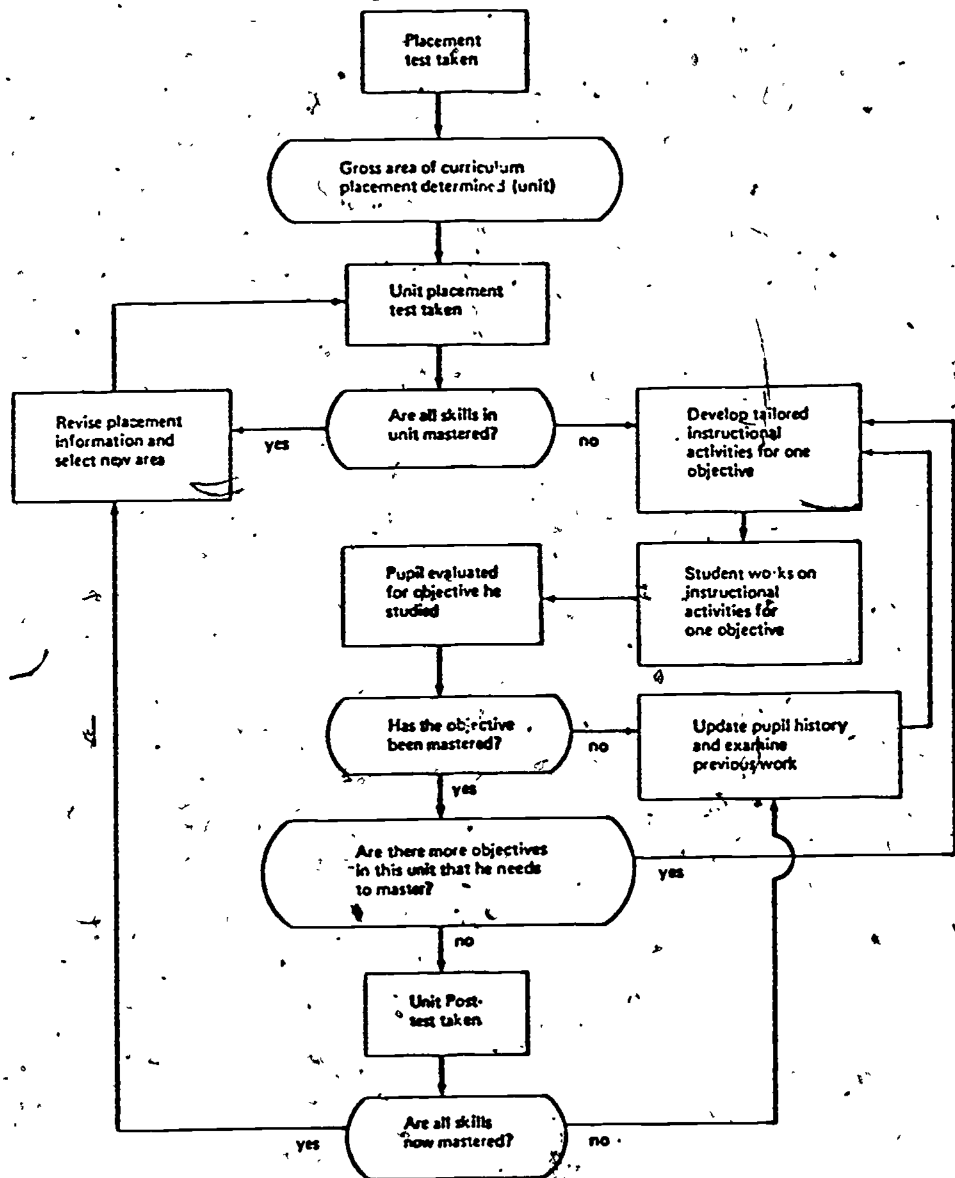


FIG. 4 Instructional process flowchart for the IPI procedure. (Adapted from Lindvall, Cox, & Bolvin, 1970)

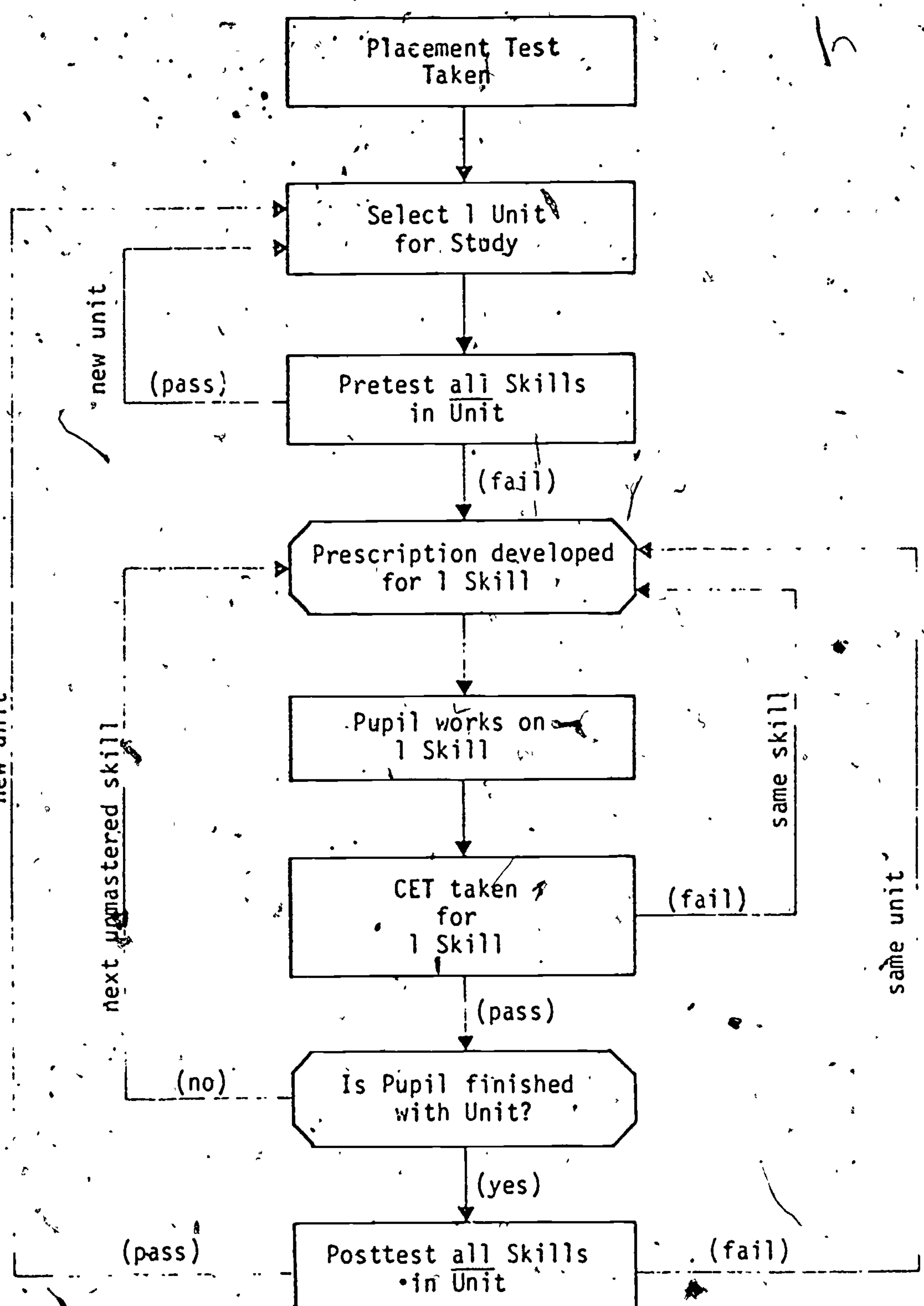


Figure 4

Current IPI Testing and Instructional Procedure
(Modified from Lindvall and Cox, 1969.)

MATHEMATICS PLACEMENT PROFILE

Name John Smith Date 5/70 Grade 5

School Sweetdale Teacher Mrs. Jones Room 12

Mathematics Area	Placement Level A-G							Placed at Level
	A	B	C	D	E	F	G	
Numeration/Place Value								E
Addition/Subtraction								F
Multiplication								E
Division								D
Fractions								D
Money								--
Time								--
Systems of Measurement								F
Geometry								E
Applications								D

Figure 5

Example of Placement Profile for a hypothetical student with respect to the mathematics curriculum of Individually Prescribed Instruction

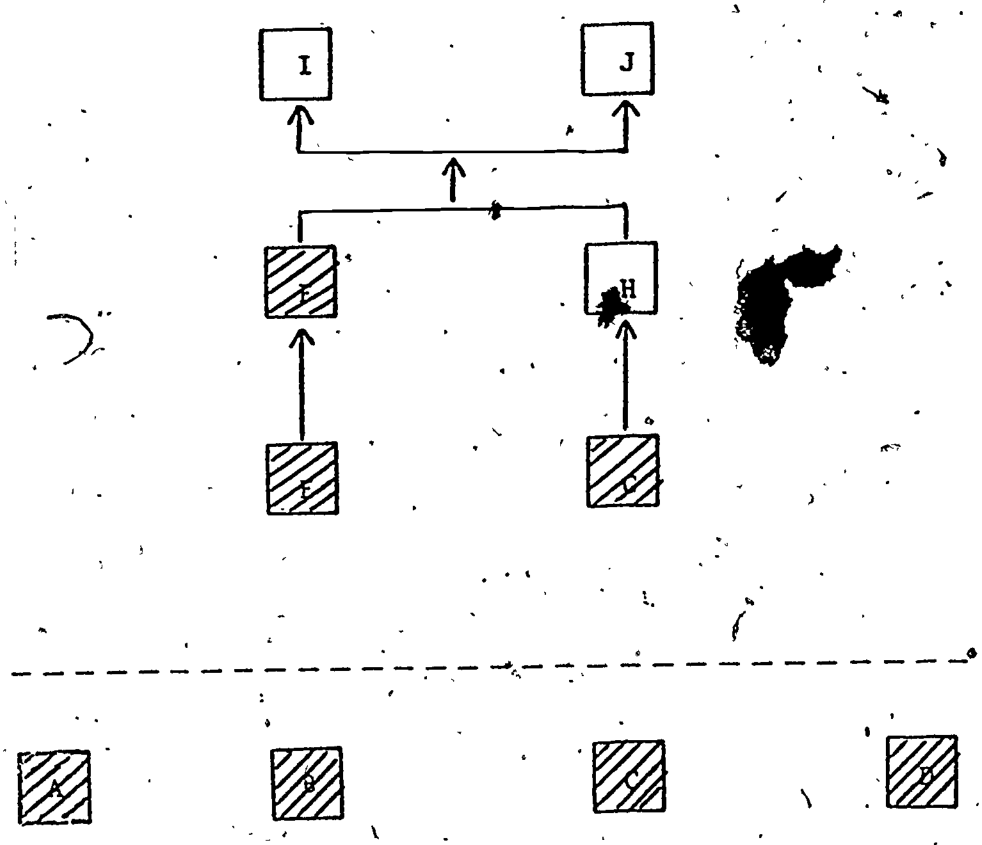


Figure 6

Placement profile for a hypothetical student. (Shaded boxes mean that the student has sufficient mastery of these instructional goals to proceed with a new instructional goal.)

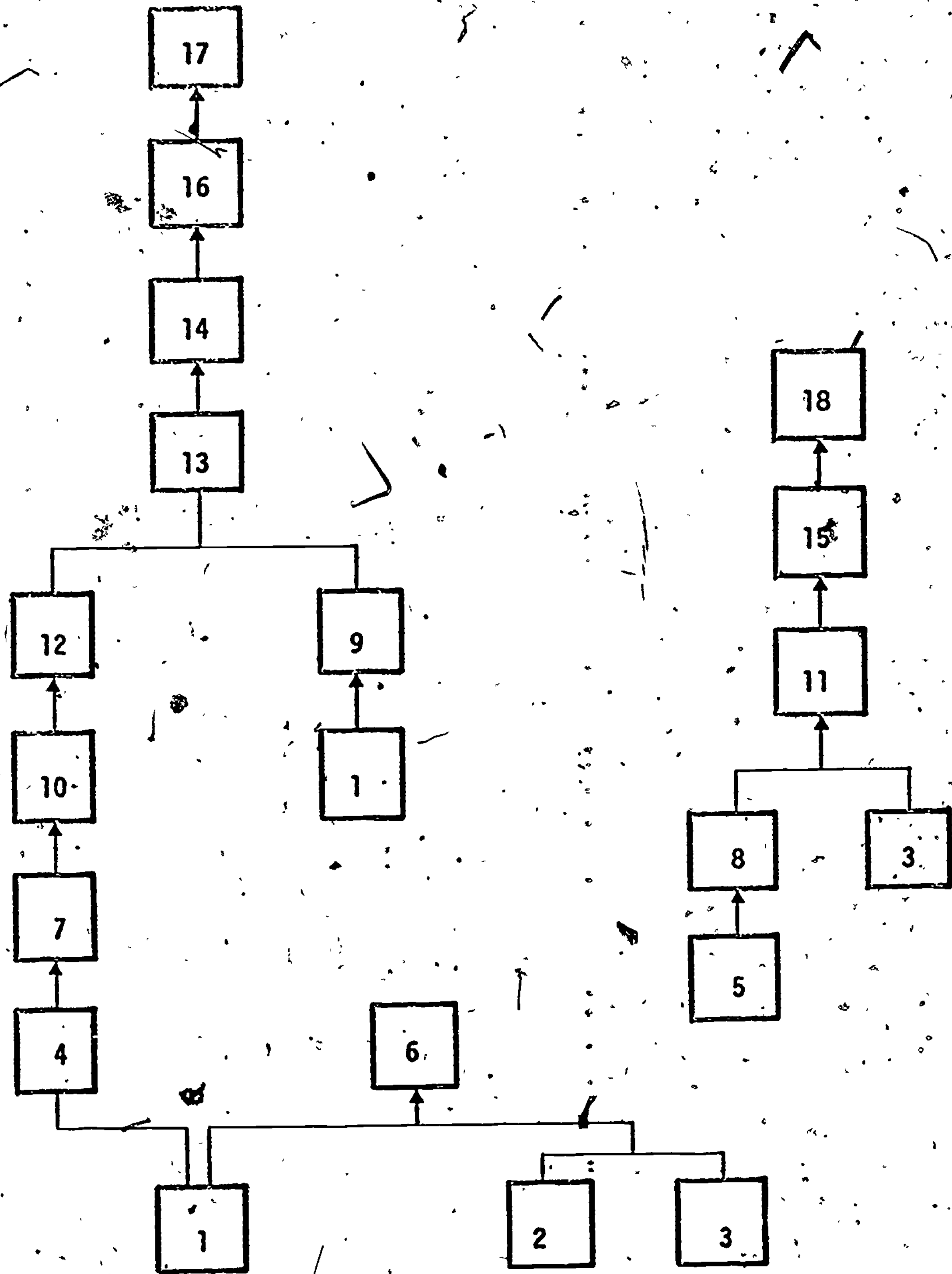


Figure 7

An Example of a Hierarchy of Skills
in an IPI Mathematics Unit

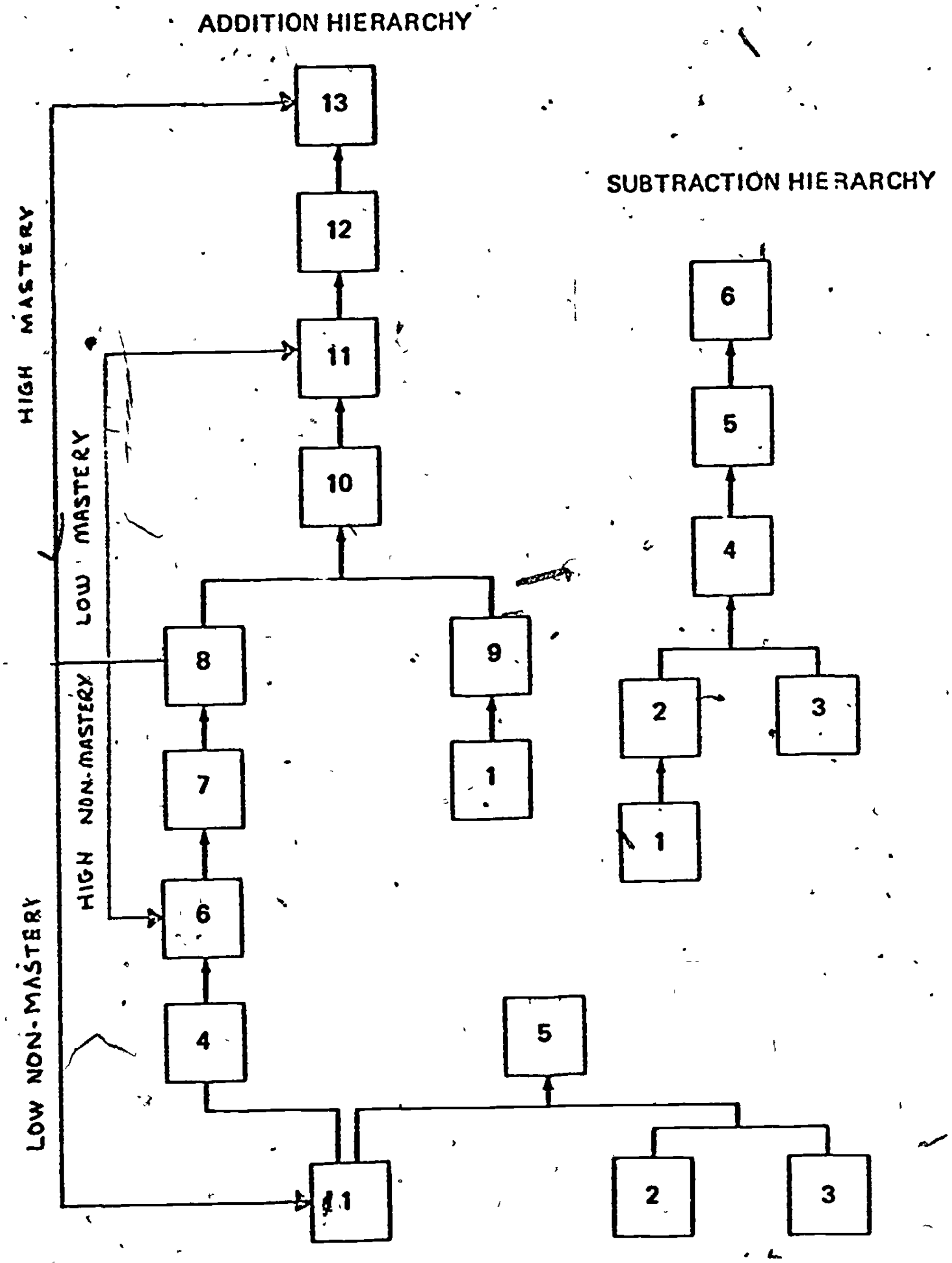


FIG. 8 Hierarchies of objectives for an arithmetic unit in addition and subtraction. (Adapted from Ferguson, 1969.)

*Table 2

PRESCRIPTION FORM FOR ASSIGNING SPECIFIC LESSON MATERIALS IN A UNIT IN INDIVIDUALIZED MATHEMATICS*

*Table 2 has been removed because the publisher did not grant ERIC reproduction permission. See MEASURING PUPIL ACHIEVEMENT AND APTITUDE, Second Edition, by C. Mauritz Lindvall and Anthony J. Nitko © 1975 by Harcourt Brace Jovanovich, Inc. (p. 216).

Table 3. Examples of three of the the many clusters of items that could be forme for an elementary school arithmetic objective.*

Objective: Multiply a two-digit number by another two-digit number using the multiplication algorithm.

General Description of Item Cluster*	Sample Items		
No carries	43 x 22	51 x 11	32 x 23
Single carries to ten's place	27 x 13	13 x 24	12 x 47
Single carries to ten's place and hundred's place	67 x 12	56 x 17	22 x 49

*Based on Ferguson, R.L. and Hsu, T.C. (1971).

DIAGNOSTIC TEST ERROR CATEGORY SUMMARY

ERROR CATEGORY	NUMBER OF ERROR'S ON TEST	INSTRUCTIONAL OPTIONS
1. DIVISION FACT ERROR	2	A. PRACTICE WITH FLASH CARDS. B. USE IPI LESSON NUMBER M/28D.
3. SUBTRACTION ERROR	1	A. COMPUTER-ASSISTED DRILL & SKILLS 1, 2, 3. B. PRACTICE WITH FLASH CARDS.
5. NO ZERO IN ONE'S PLACE	1	A. IPI LESSON NUMBER M/40F, PP. 4, 5, 6, 21, 22. B. MODERN MATH SERIES, PP. 78-79.

Figure 9. Example of a computer-assisted diagnostic error summary for elementary school mathematics (From Binstock, L., Pingel, K., and Hsu, T.C., 1975)

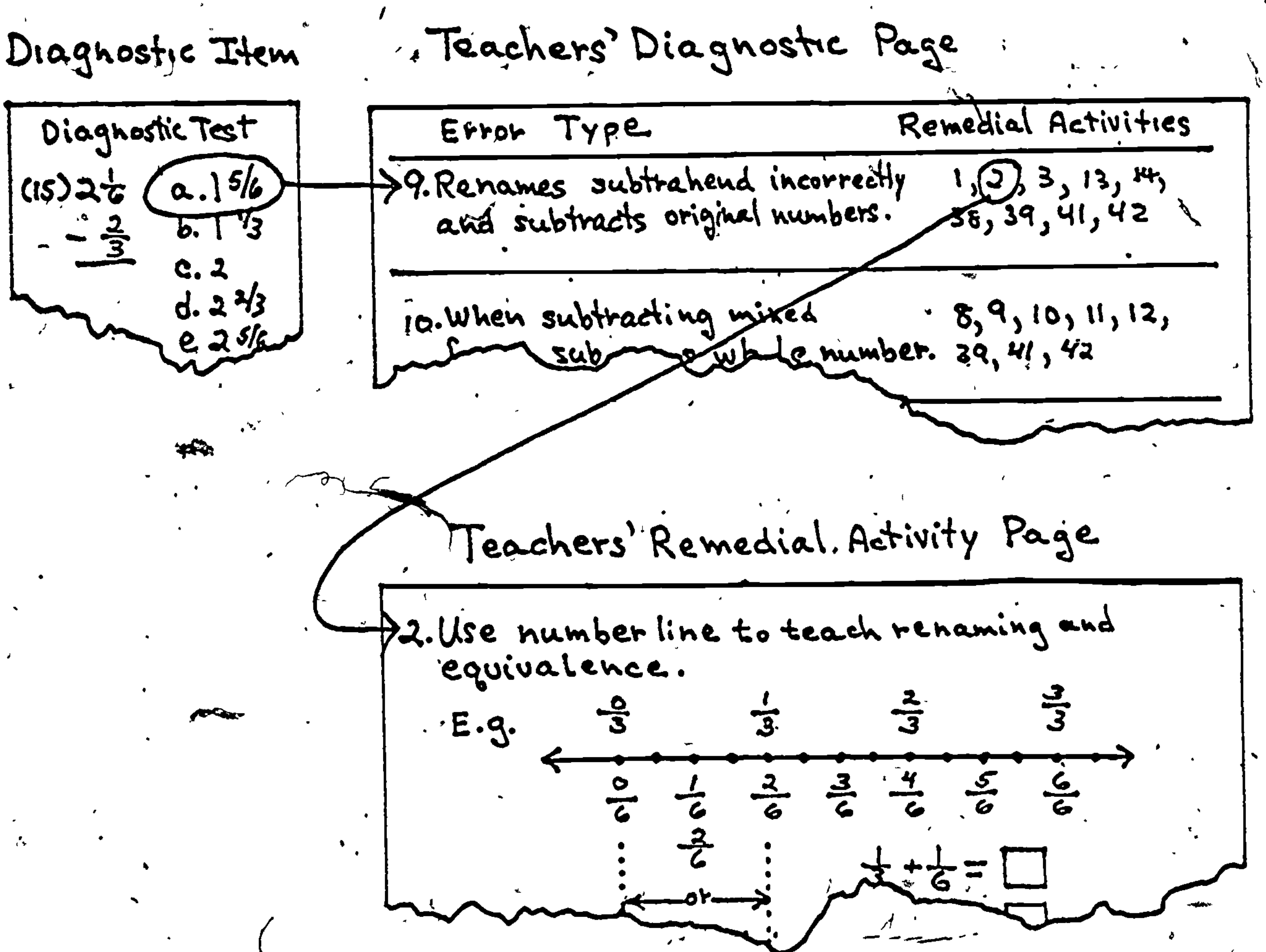


Figure 10

Example of the CHILD System of Error Diagnosis Used In Dade Co. Public Schools, Miami, Fl.

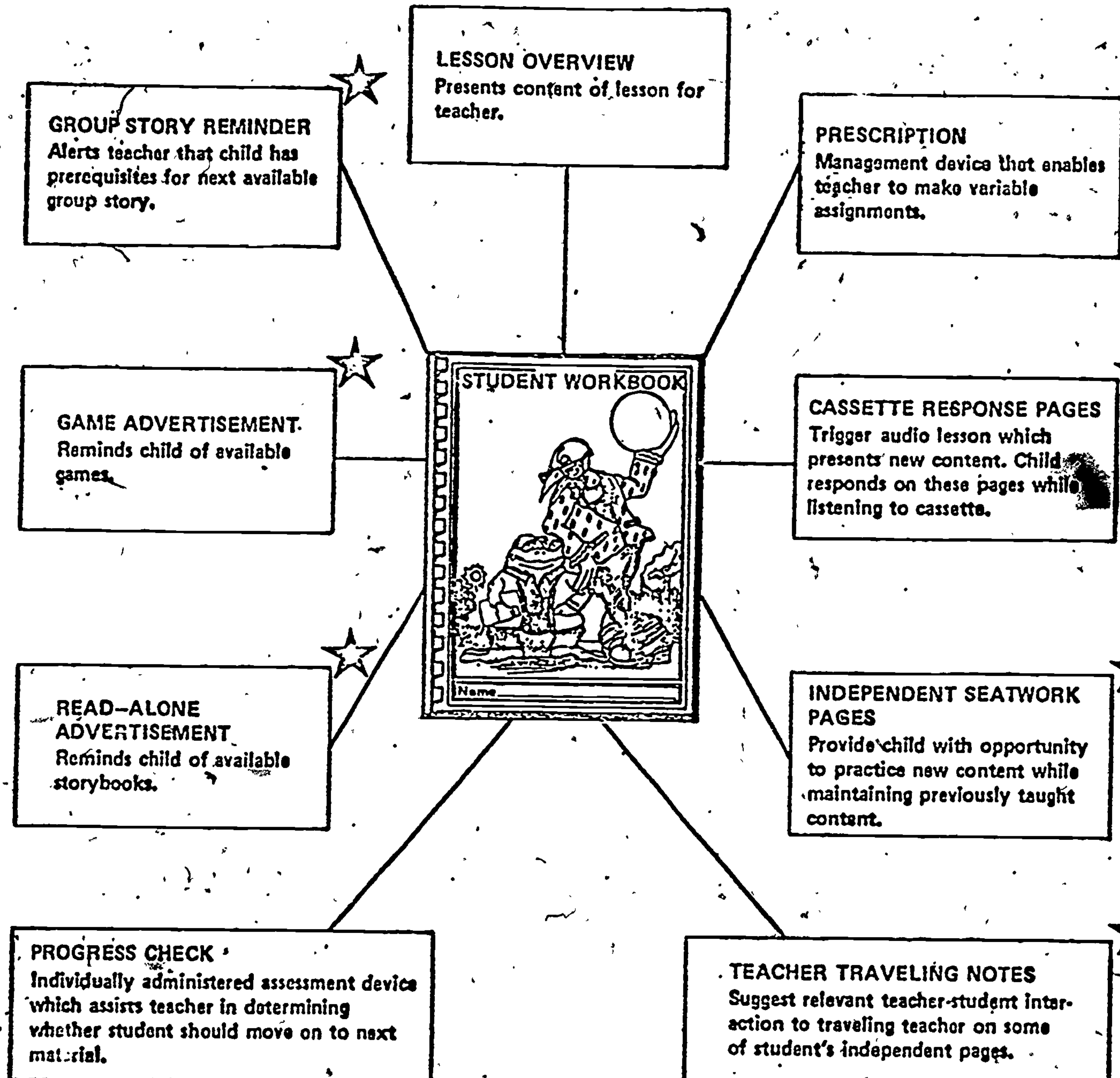
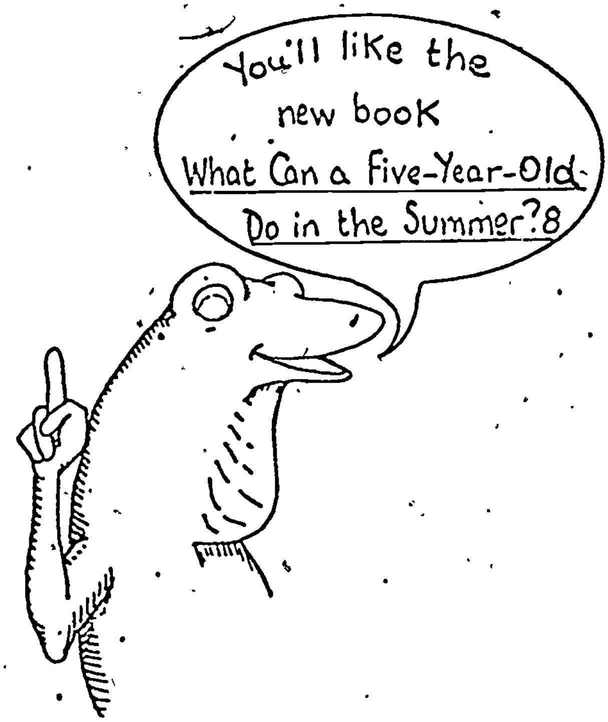


Figure 11 Instructional resources in Levels 3 through 14.
(From Beck, 1975)

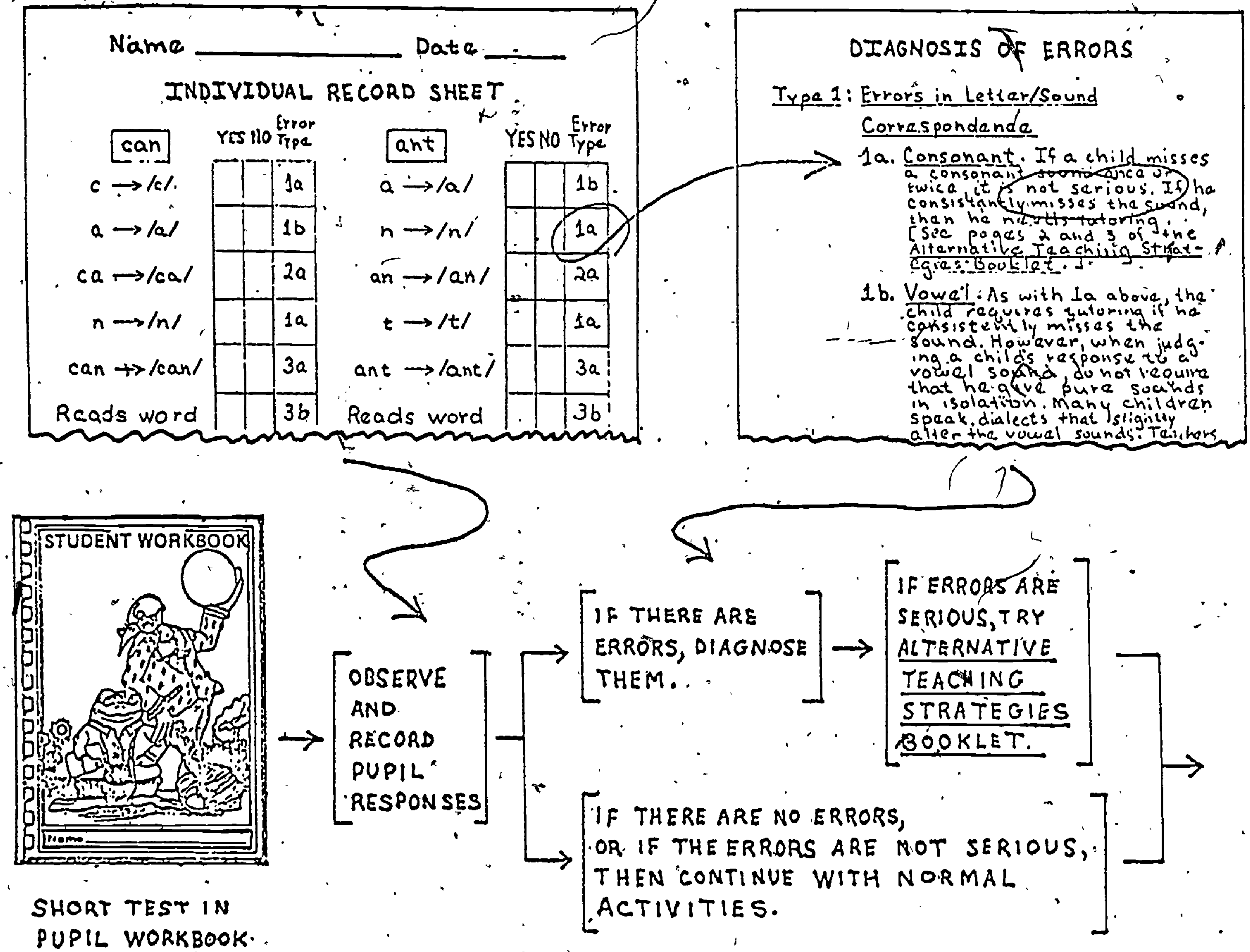
8-6 Prescription

	49, 50, 51, 52, 53  8-6-A	Cassette
	54, 55, 56, 57, 58, 59, 60, 61, 62	Workpages
	63, 64, 65  8-6-B	Cassette
	66, 67, 68, 69, 70, 71, 72, 73	Workpages
	See your teacher	Progress Check 8-6



8-6 Prescription continued on next page

Figure 12



DIAGNOSTIC TESTING IN THE NEW PRIMARY GRADES READING SYSTEM

Figure 12 (cont)