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ABSTRACT

Instructional Curriculum Mapping (ICM) is a set of guidelines for diagramming the interrelationships among objectives from different domains of learning. Five major learning domains are identified: (1) intellectual skills; (2) cognitive strategies; (3) verbal information; (4) motor skills; and (5) attitudes. This paper examines the functional relationships among objectives from these five domains. Diagramming these relationships provides a visual analytic tool for the teacher in instructional sequencing and makes evident the need for instructional strategy decisions based upon the functions being served by the performance objectives. This report illustrates with flow charts how ICM is set up for accomplishing educational objectives by using the interdependancy of the major learning domains. (JD)

Instructional Curriculum Mapping

by

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Although educators have been aware of the fact that there are many different kinds of learning, and that different educational methods are needed to effect different outcomes, little attention has been paid to the interrelationships between the different types of outcomes and the implications these relationships have for curriculum and instructional design. For example, Bloom's taxonomy (1956) is a categorization system for relating objectives in the "cognitive domain" based on the conceptual foundation "complexity" of the skills. However, the cognitive skills are not related to other domains. Likewise, Gagne (1970) addresses the relationships of cognitive learning types based on the conditions of learning necessary to attain them, but this system also deals only with the one domain. Another taxonomy, Karthwohl's (1964) taxonomy of the affective domain, deals only with the relationships among objectives within that domain. What is lacking, it seems, is a set of guidelines for representing the relationships among objectives from different domains.

Gagne and Briggs (1974) described five domains of educational out comes, viz., cognitive strategies, intellectual skills, verbal information, attitudes and motor skills. Their categorization of educational outcomes is an extention of previous thinking in the field in that the "cognitive domain" has been expanded into three categories; intellectual skills, cognitive strategies, and verbal information. The other two domains, motor skills and attitudes, essentially parallel what was previously called the psychomotor and affective domains. This paper will attempt

to look at the functional relationships among objectives from these five domains of learning.

The curriculum for most courses contains objectives from more than one domain. Even though they may be unstated, affective objectives accompany most planned cognitive goals. However, when specifying the goals or objectives for a course we often focus only on the cognitive goals, and without consciously considering the affective objectives, it is possible instructional decisions may be very effective for the cognitive purpose, but ineffective for the affective purpose. This could also be true for the motor skills and affective or the motor skills and cognitive domains. It is probably accurate to say that developers and curriculum designers have not optimized research related to learning in designing well sequenced, appropriately delivered instruction to achieve the multiple objectives existing in most courses.

Instructional Curriculum Mapping (ICM) is a set of guidelines for diagramming the interrelationships among objectives from different domains. These guidelines are derived from an analysis of the functions component objectives serve in the learning process. Diagramming these relationships provides a visual analytic tool for instructional sequencing, and makes evident the need for instructional strategy decisions based upon the functions being served by the performance objectives.

An understanding of what ICM hopes to accomplish is best illustrated by analyzing an attitudinal objective a teacher has for a course. The course is about "teaching methods" and a desired attitudinal outcome is:

> "The prospective teachers will choose to use the criterion-referenced model (CRM) in evaluating their students."

The above objective can be observed; i.e., one could follow students into the classroom after graduation and determine whether or not they

were indeed using CRM evaluation.

The question is, what other behaviors are necessary (or will have to be developed or changed) for a student to leave with a positive attitude toward CRM? There are probably a number of things. First, one would expect the student would have to have some facility in applying CRM techniques (basically intellectual skills objectives). Second, the student would need some information as to the value of CRM (or would have to come to value its application). It is possible that the teacher could create in the student a positive attitude toward CRM before teaching him to apply the model. Some of the recognized techniques of attitudes change include the use of verbal report (Hovland, 1953), hence verbal information objectives may facilitate the achievement of the intellectual and affective objectives. In fact, it is probably true that if we can develop in the student a positive disposition toward CRM he will take less time to master the intellectual skills necessary to apply the model.

Figure One represents an ICM for a unit on Student Evaluation and Grading in a course on "college teaching."

The attitudinal objective previously mentioned is represented in the upper right hand corner of the ICM and is identified by the verb "choose." Gagne and Briggs (1974) generated a set of nine verbs representing the behaviors to be exhibited in each of the five domains and their subdivisions. The use of these "standard verbs" make the ICM more easily understood since each type of learning can be easily identified.

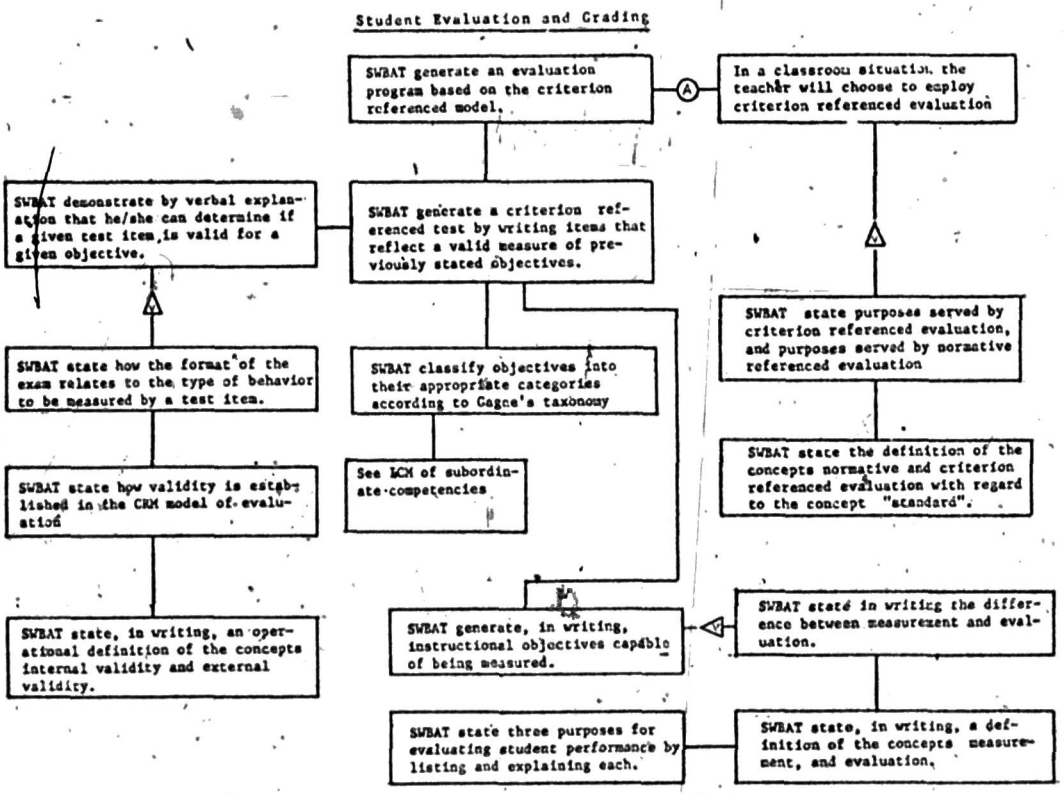


FIGURE 1.

The verbs used by Gagne and Briggs are:

Domain	Verb
Attitudinal Domain	chooses
Motor Skill Domain	executes
Cognitive Strategy Domain	originates
Verbal Information Domain	states
Intellectual Skills Domain	
1) problem solving	generates
2) rule using	demonstrates
3) defined concept	categorized
4) concrete concept	identifies
5) discrimination	discriminates

Gagne and Briggs, p.85

The objectives in the ICMs shown in this paper employ these verbs.

One can see from Figure One that the attitudinal objective has connected below it two verbal information objectives. The assumption is that if students are asked to perform these two behaviors they will be more likely to have a positive disposition toward CRM than if they were not.

The value of the ICM to the course developer in this case derives from the realization that achievement of the attitudinal objective is to be effected through the achievement of some verbal information objectives requiring different learning strategies than, say, concept learning tasks.

Within the intellectual skills domain, the objectives take on the true hierarchical relationship. The lower level skills, such as concept learning, lead into rule using skills, which lead into problem solving skills. The ICM is not, however, a true intellectual skills hierarchy. Rather, the ICM is a graphic representation of the performance objectives of each domain and their relationships both hierarchical and functional to each other for a defined instructional "unit."

Most courses include a number of sequential instructional units and many times the attitudes elicited in one unit form the rationale and foundation for a following unit. This can be seen in the ICM depicted in Figure 2. The attitudes developed in Unit One, namely a positive attitude toward specifying educational outcomes and using CRM, provides the rationale for beginning a unit on improving the quality of instruction through using the most effective methods.

Again, the ICM in Figure 2 shows an attitudinal objective at the top right hand corner. In this particular case where the attitude is to be effected through the achievement of intellectual skills certain conditions of learning are needed to accomplish the desired attitude.

Knowledge about alternative media will be gained through the accomplishment of the intellectual skills objectives, but this may not be enough to change a student's attitude toward using these media. Here the ICM can become the basis for an instructional strategy decision that might otherwise have been overlooked; namely, to expose the students to as many different media (appropriate for certain types of learning) as possible, and to make this exposure as rewarding as possible. This decision will affect media selection throughout the course, even though, theoretically, for the objectives in the intellectual skills domain a single medium (text) might have proven sufficient.

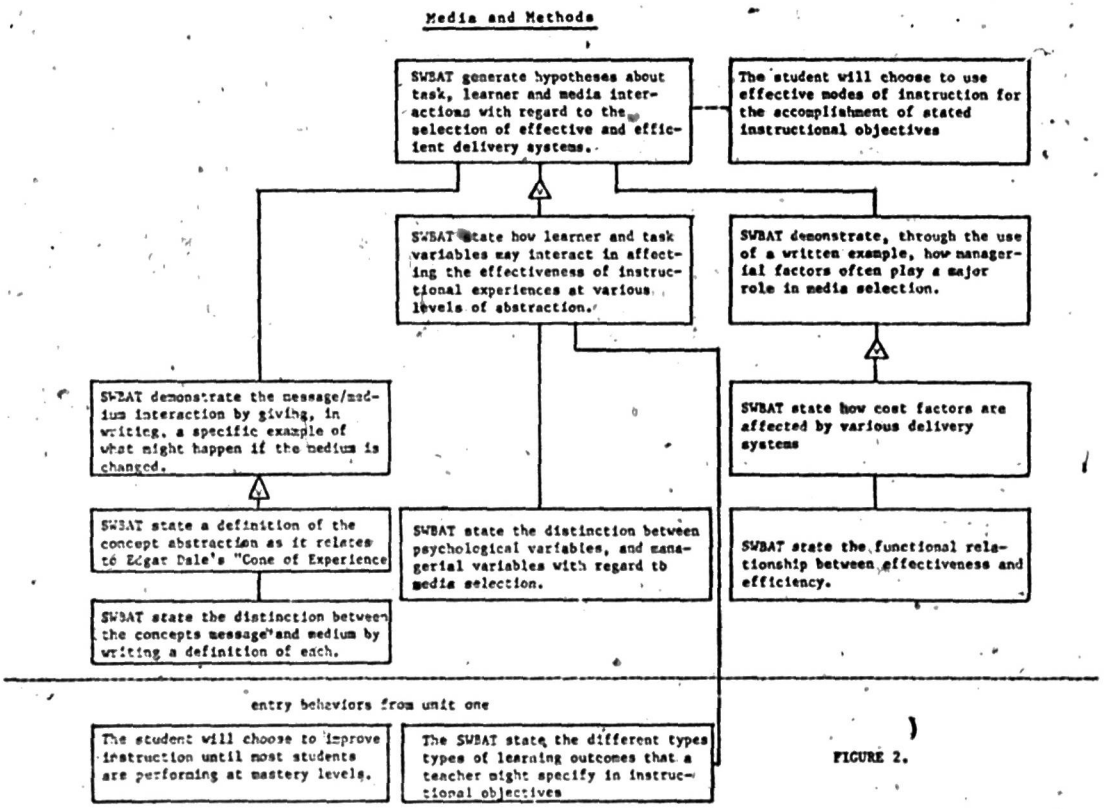


FIGURE 2.

Unit Three (Figure 3), of the course being used to illustrate ICM contains two examples of motor skills, viz., the execution of two formal instructional presentations. The first is presenting a "traditional lecture" with emphasis on voice control, body gestures, pace, etc., and the second is a presentation with an emphasis on the intellectual skill of asking "leading questions." Since both these skills depend upon behaviors from other domains, it's necessary to understand which parts of the task are intellectual skills (in order to properly evaluate their attainment) and which represent a "motor performance"--the delivery of the presentation. ICM helps the curriculum planner to see where performance must be divided into "knowing," and "doing" components. Hence, the course must now consider another condition of learning associated with motor skills, practice with verbal/visual feedback. In this case, the strategy of microteaching seems to best fit the situation.

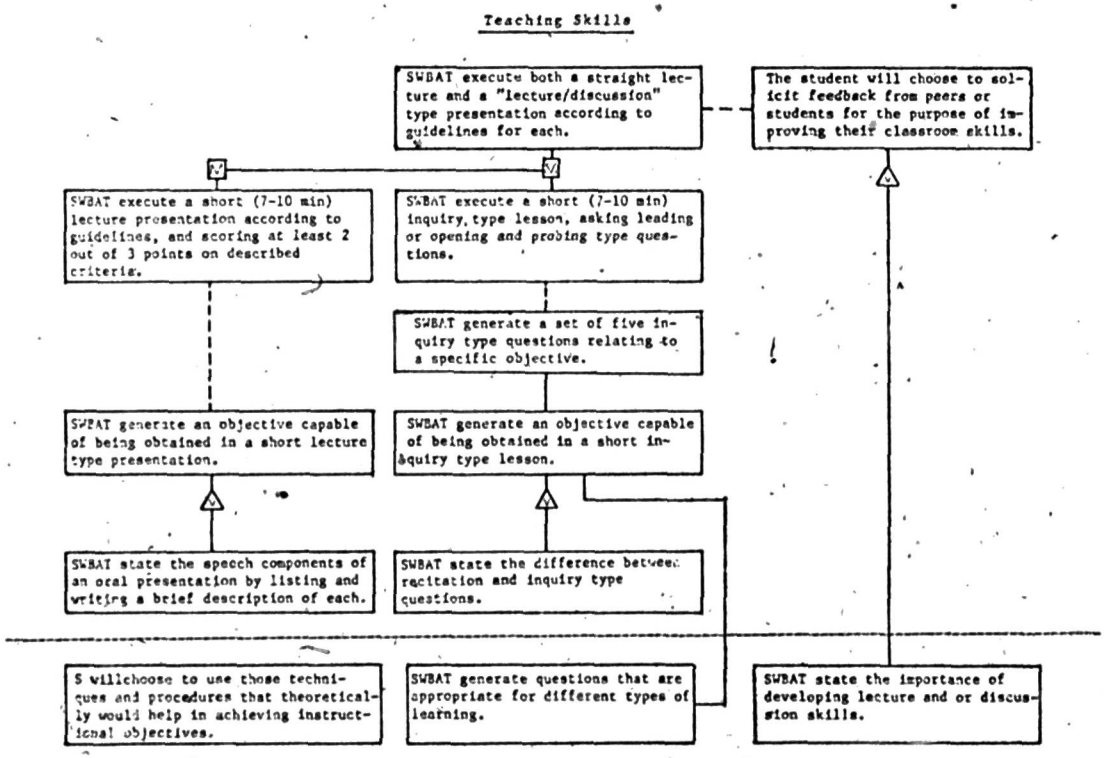


FIGURE 3.

Figure 4 completes the ICM for the course being used to demonstrate ICM.

One can see that the accomplishment of the affective objective of unit four should be facilitated by the accomplishment of the affective objective for Unit 2. Likewise, the intellectual skills objective should be facilitated by mastery of earlier skills objectives.

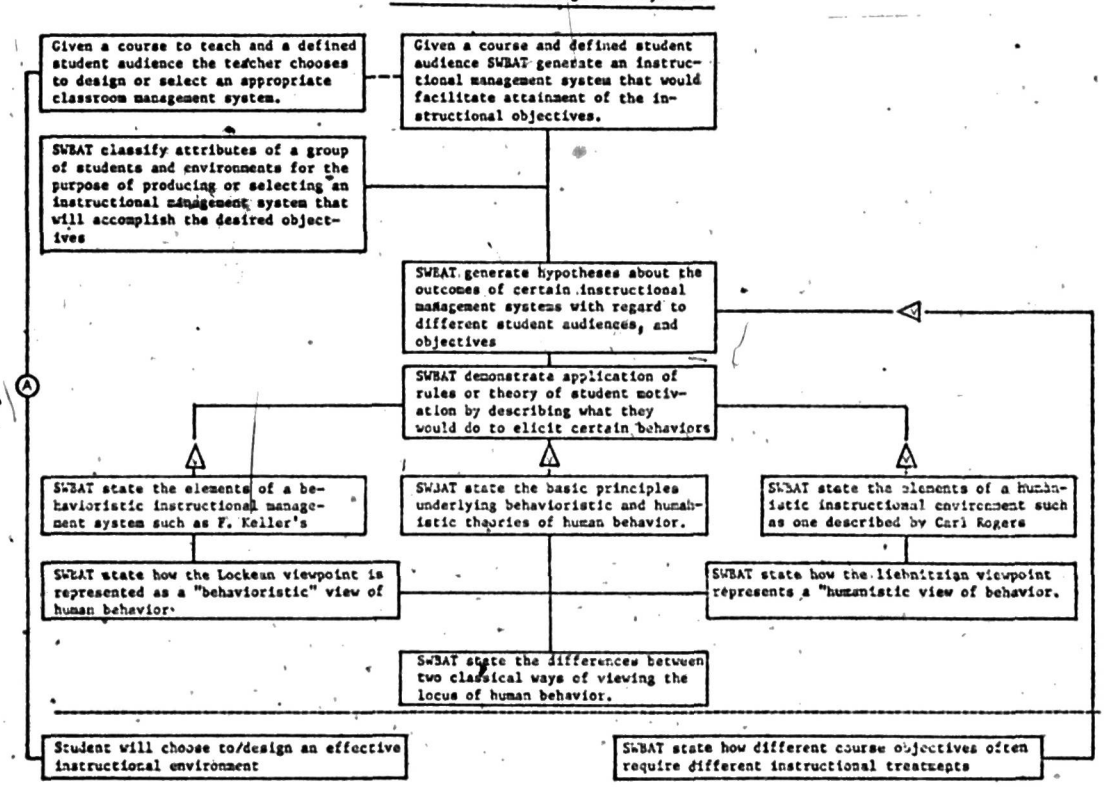


FIGURE 4.

DEVELOPING THE ICM

The ICM's represented in this paper were designed in stages beginning with the specification of the major intellectual skills, attitudinal objectives and/or motor skills, to be accomplished in each unit. These objectives are represented below. Note the use of the standard verbs (Gagne and Briggs, p. 85).

Unit One - Student Evaluation

Intellectual Skills - The student will be able to (SWBAT) generate an evaluation program based on the Criterion Referenced Testing model.

Attitudes - Students will choose to evaluate their students' classroom performance using the CRM where appropriate.

Unit Two - Media and Methods

Intellectual Skills - SWBAT generate hypothesis about task, learner, and media interactions with regard to the selection of effective and efficient delivery systems.

Attitudes - The student will choose to use effective modes of instruction for the accomplishment of stated instructional objectives; i.e., an effective environment.

Unit Three - Teaching Skills

Intellectual Skills - SWBAT generate an organized lecture type presentation.

SWBAT generate inquiry type questions spontaneously during a discussion type presentation.

Attitudes - The student will choose to solicit and use student and peer feedback for the purpose of improving "teaching skills."

Psychomotor - The student will execute both a straight lecture and a lecture/discussion presentation according to previously stated criteria.

Unit Four - Classroom Management

Intellectual Skills - Given a course definition, and hypothetical student population the SWBAT generate and support hypotheses about the effectiveness of various classroom management systems.

Attitudes - Given a course to teach, and a defined student audience, the prospective teacher chooses to select a classroom management system based on theoretical considerations as to its probable effectiveness; appropriateness for the learner and the task within the environment.

These objectives are then placed at the top of the ICM, as they are representative of the cumulative learning from that particular unit. The relationships among units can now be diagrammed (Figure 5). One can decide if they are sequential and cumulative or if they may be taught in any order. It is interesting to note that even if the intellectual skills objectives appear to be independent of each other, the attitudinal objectives may not be. In other words, the possession of a particular attitude or disposition toward an idea, concept, intellectual skill, etc., may be seen to facilitate the acquisition and possible retention

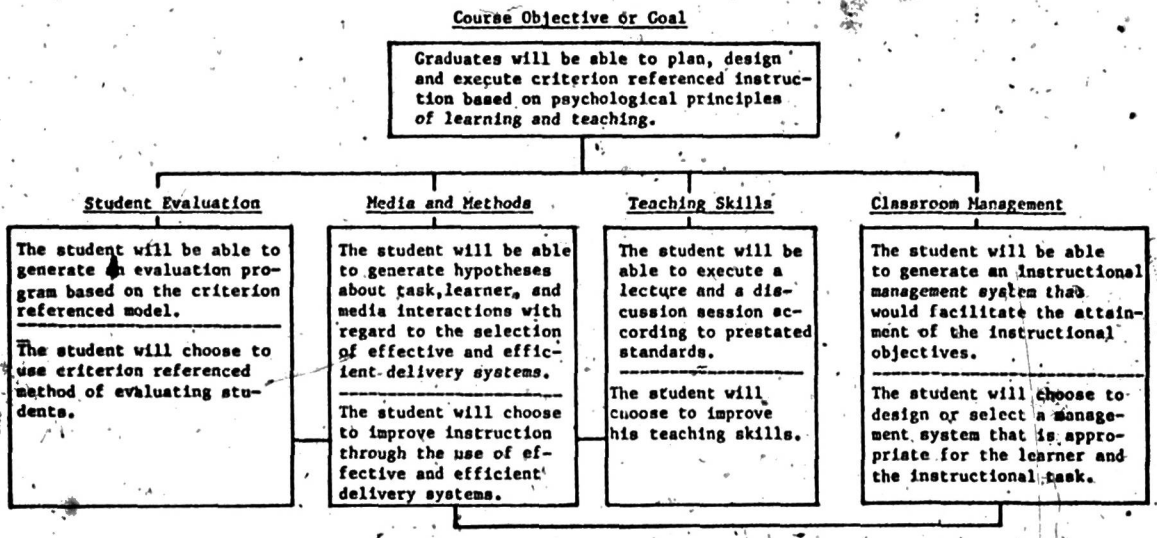


Figure 5.
Course Goal and Related Unit Objectives

of that knowledge, skill, motor behavior or other learned capability.

After the interrelationships among the major unit objectives have been established it is possible to describe subordinate "enabling" objectives. These are behavioral objectives (learned capabilities) the student will acquire in order to perform the major unit objectives. To

facilitate interpretation and development of the ICM some diagrammatic conventions have been adopted:

1. When different domains intersect a symbol designates the change:

   a) —▽— is used to show a verbal information input

   b) —(A)— shows an attitude input

   c) —[M]— motor skills input

   d) ——— intellectual skills input

2. Relationships among objectives in the same domain are shown with straight lines in a conventional flow charting manner. If the standard verbs are used to describe the learned capabilities the developer will have little subsequent trouble in determining the type of learning being represented, and he can then start diagramming the relationships. The intellectual skills hierarchy remains relatively the same as described by Gagne (1970), where problem solving is recognized as the highest order skill followed by rules, concepts, and discriminations, respectively. By looking at the major intellectual skills for a unit the designer can begin a "task analysis." One procedure for constructing this hierarchy is to ask the following set of questions:

   1) To define "Problem solving" objectives: "What problems will the student be able to solve at the conclusion of this unit?"

   2) To define "Rule using" objectives: "What set of rules must the learner apply (learn) in order to solve the subsequent problems?"

   3) To define "Concept" objectives: "What concepts (categorizations) must the student apply (learn) in order to use subsequent rules or procedures?"

4) To define "Discrimination" objectives; "What discriminations must a student make (learn) in the process of differentiating between attributes of different concepts?"

The answers to these questions will provide the objectives for the intellectual skills domain, and these objectives can be diagrammed in a hierarchical manner. Notice the use of the work learn in parentheses above. In the process of doing a task analysis there are many discriminations, concepts, rules and other types of behavior that the learners, for whom the instruction is being designed, are assumed to possess. For instance, if we are teaching intermediate algebra we assume that the student can add, multiply, subtract and divide, he can solve simple arithmetic problems in a base ten system, he can count, etc. The task analysis will not dissect the task all the way down to performing simple arithmetic operations because we expect the students can recall and use these operations since they used them in the previous course "elementary algebra." Likewise, we don't expect to have to teach the student to read, or write numbers on paper. The task analysis looks at the behaviors we expect to teach in order to enable the student to perform the particular terminal behaviors we have described.

The task analysis for intellectual skills, then, seldom contains a complete hierarchy of all the subordinate intellectual skills. The starting and termination points are usually described by the level of the learners and many assumptions are made about previously acquired behaviors that will affect the learning to take place.

Whether attitudes are primary or secondary to intellectual skills in our public educational institutions is a philosophical argument that one could not expect to answer in any simple way. However, after being stated as educational goals, they are too often forgotten when it comes to planning instruction to achieve them. Attitudinal objectives may be

specified as a sequence of desired dispositions which the learner might exhibit through self report or actions. There are basically two approaches in the literature that may be used in designing instruction to change attitudes (or formulate new ones). One is based on the information approach described by Estes (1972), the other on the "behavior change" approach described by Bem (1970). With regard to interrelationships between objectives from the different domains, Estes' approach would make use of verbal information, and Bem's approach would interface with intellectual, or even motor skills.

Estes (1972) found that information about the magnitude and probability of reinforcement (even though the information may be false) can facilitate attitude change. In this case, the learner could be supplied with verbal information presented in a logical manner by a credible source, and if he "learned" this information an attitude change would probably accompany it. Bem theorizes that attitudes should follow behavior (1970, p. 57). Although this is not inconsistent with Estes' approach, this implies attitudes of certain types, e.g., toward the subject matter being studied, are likely to be more positive after the student has mastered that subject matter. This makes intuitive sense, since we would expect someone that could "do" statistics would be more positive towards it than someone didn't learn it well. If we were trying to facilitate attitude attainment or change by this approach we would wish to design our instructional system so the intellectual skills are attained under the most reinforcing conditions, and the subsequent use of the skills is designed into the program so that a high degree of facility with the new skills is attained and maintained. The relationship between motor behaviors and attitudes would seem to follow the same model; reinforced incremental learning, successful performance of the terminal

skill, and maintenance of the skill.

Implications of Interdomain Relationships.

Much instructional methodology recognizes interdomain relationships. For instance, the driver education student learns "the steps" in pulling away from a curb. Whereas the experienced driver probably does not think of the independent steps, the learner can facilitate behavior acquisition by "talking it though." In this case, verbal information serves as an "input" for the desired learning outcome, a motor skill. The function served by the verbal information is one of providing a cognitive routine for sequencing the motor performances to be learned. If we observe how other domains of educational outcomes facilitate motor skills learning we can see that attitudes probably play a role, in that they affect the perseverance of a student with regard to the work requisite to becoming proficient.

Interaction also exists between types of learning from other domains. These interrelationships are diagrammed in a matrix form in Figure 6 showing the inputs or enabling objectives along one dimension and the outputs or behaviors to be learned along the other. In order to see what function "attitude behaviors" might play in learning "intellectual skills" find attitudes on the "input" side of the matrix (top) and I.S. on the output (left side) and follow the column and row to where they intersect, e.g., the function served by developing positive attitudes would seem to be motivational in that changing an attitude held by a majority of the target audience would lead to better acceptance of subsequent intellectual skills instruction. The relationship between the attitude and the intellectual skill (course level) objective might

FIGURE 6

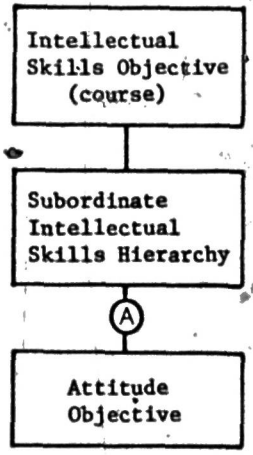
DOMAINS - - FUNCTIONS MATRIX

Inputs

Outputs	Cognitive Strategies	Verbal Information	Motor Skills	Attitudes	Intellectual Skills
Cognitive Strategies	One might develop strategies for developing new strategies. (speculation)	Verbal information may mediate a transfer of learning allowing learner to adapt old strategies to new situations		Dogmatism, field dependence, etc., may affect learner's ability or perceive new strategies.	A repertoire of I.S. skills probably lead to a generalized "strategy" for solving similar problems. Gagne (1968)
Verbal information	Strategies for memorizing work strings, facts, or organizing meaningful knowledge Eg., Megamemory research by Flavell & Rohwer	A number of studies show that the learning of one set of information influences the learning of a second set (Ausubel). Many theories imply organization into propositions "associative" in nature. (Klausmeier)	reading may be dependant upon motor coordination. (Wilson/ Geyer, p. 60) Clinical application (directional orientation)	Attitudes about source affect perception and probability that information will be learned.	Appreciation of classification routines may lead to ability to make relational or associative "propositions" enhancing verbal enhancing verbal learning. Klausmeier
Motor skills	Strategies for learning new motor skills may exist e.g., patterning, faded cues, successive approximation, cognitive routines	Provides cues for the sequencing of a motor performance.	Developed in a progressive manner so that part skills may be combined to form more complex skills.	Probably affect effort learner will put into learning new skill or improving an existing one.	Executive subroutine which governs the pattern of responding is an intellectual skill that may be previously learned. Gagne
Attitudes	The ability to self analyze one's attitudes may be facilitated by learning a cognitive strategy, e.g., strategies for resolving dissonance.	May input directly into some attitude objectives; gives learner expectation of reinforcement available for making certain choices.	The attainment of a skill leads to a more positive attitude toward the use and value of that skill.	Attitudes toward persons, places or things are mutually supportive; changing one may necessitate changing many. (cognitive consistency theory)	The attainment of I.S. may lead to a more positive attitude if their practice is reinforcing to the learner.
Intellectual Skills	Affects ways learner can approach task of learning new skills.	Input into I.S. at any level, serve to clarify terminology and mediate learning transfer, also may serve as advance organizers Defined concepts may first be learned as verbal information.		A positive attitude probably facilitates motivation needed to make work of learning worth doing. A negative attitude probably serves as a perceptual screen.	A hierarchy exists within the intellectual skills domain so that learning a higher level skill is facilitated by recall of previously learned simpler skills.

be diagrammed as shown in Figure 7.

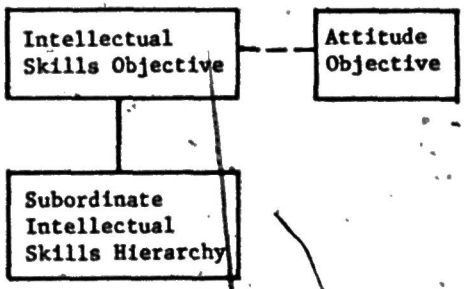
Figure 7



This diagram implies that attitude change precedes attainment of the intellectual skills and therefore the instruction should include methods and content aimed at attitude change in the orientation stage of the course, i.e., before "skills" instruction.

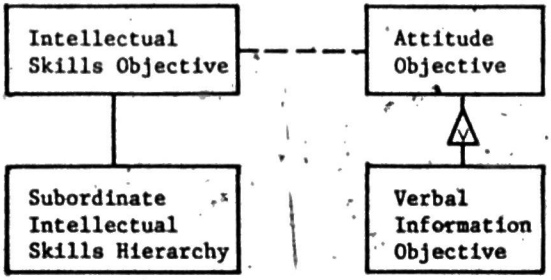
Diagrammed differently as in Figure 8, the attainment of intellectual skills is seen to be the input or competency preceding attitude change. In this case, according to the matrix, the learner attains a more positive attitude due to the development of a skill with reinforcing potential.

Figure 8



In Figure 9 a new dimension is added to the curriculum.

Figure 9

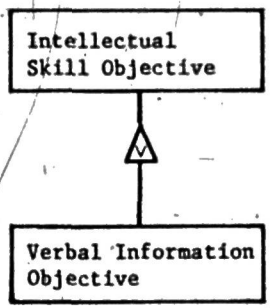


The designer has now added another competency to be attained by the learner, i.e. the verbal ability to state something. With regard to changing an attitude the learner may be stating the value of something, the rationale for something, etc. Here the attainment of the attitude is to be facilitated by two factors, the verbal information behavior and the intellectual skills behavior. The most efficient instructional decision would probably be to elicit the verbal information behavior first since a more positive attitude should facilitate attainment of the I.S., and since it takes far less time for the learner to attain the V.I. skill.

Probably one of the most common interdomain relationships encountered by the instructional designer is that between Verbal Information and Intellectual Skills. It is improbable that a designer is interested in the complete hierarchy of I.S. necessary to attain even a modest problem solving competency. One reason might be that there are many ways to solve most problems (or classes of problems) and instructionally we generally focus on only one or a few approaches at one time. Therefore, the course curriculum is but one example of what "might be possible."

Secondly, many problem solving competencies involve the use of previously learned problem solving skills, concepts, etc. In this case it is not necessary to diagram the entire hierarchy of intellectual skills, but rather to recognize how they are being recalled and related through the use of verbal information. As an example, if the problem solving skill is "generate hypothesis with regard to the efficiency of two different instructional methodologies," the learner must know the relationship between the concepts, efficiency, effectiveness and cost. He can learn this relationship as verbal information, and we would expect that would be enough to allow him to solve the problem, if he has previously learned the rules and concepts expressed by simple functional relationships. The ICM for relating the intellectual skills and verbal information objectives would look like Figure 10.

Figure 10.



In Figure 10 a verbal information objective is replacing a portion of an intellectual skills hierarchy, not because it doesn't exist, but rather because it has been learned previously and is now being applied in a new context with the facilitation of the newly acquired verbal information.

Often it is the case that a few new intellectual skills, and intellectual skills from previous instruction are linked in the instructional curriculum as shown in Figure 11.

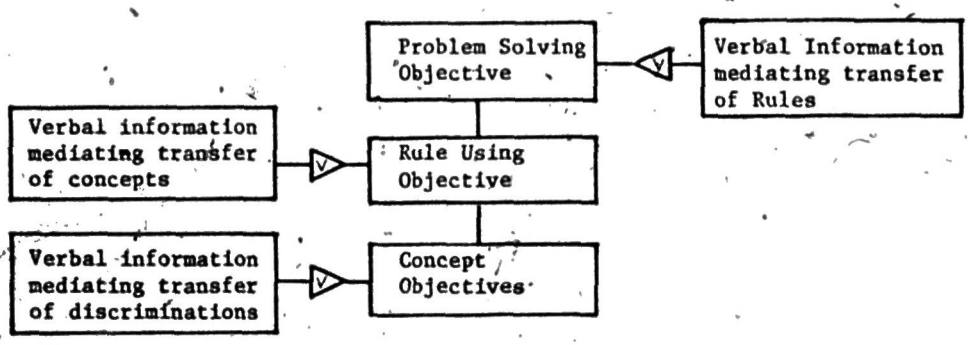


FIGURE 11.

Diagramming these relationships makes the assumptions of the curriculum or instructional developer more obvious, i.e. what skills are and are not being taught, and what skills are being transferred in. The verbal information objectives are generally derived from asking the question, "What should the students be able to say or remember about this problem, rule, concept, etc?" If having the student memorize something serves as an input to an intellectual skill it may be serving a transfer function, in which case it is being assumed a portion of the intellectual skills has been previously acquired.

The process of constructing an ICM resembles the process of writing a computer program. There are many ways to accomplish the same ends but some are more efficient than others, some are easier to construct than others, etc. It is not only possible, but probable, that two persons given the same objectives would map them differently, for as the reader can see that the process is more a set of guidelines than a scientific procedure. It is the author's opinion that instructional curriculum

mapping could open a new line of inquiry for the educational researcher as a conceptual framework for investigating different teaching methods, curriculum sequence, and course content. It should help the curriculum developer analyze the assumptions he makes of the learner's prior experience. It should be of interest to the media researcher in analyzing the effects the delivery mode is likely to have on objectives other than intellectual skills.

To date the process of instructional curriculum mapping is more conceptual than operationalized. It is hoped that the idea will seem attractive to others who might have some insight into technical approaches to better operationalize the procedure. At the least this author would enjoy dialogue on the merits or shortfalls of such technology and hopefully some will wish to share their insights into procedural development.

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