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THE ELABORATION THEORY OF INSTRUCTION: A MODEL FOR SEQUENCING AND SYNTHESIZING INSTRUCTION*

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ABSTRACT

This paper describes a novel instructional model for sequencing, synthesizing, and summarizing subject-matter content. The importance of such models is discussed, along with the need for a significant change in the role of subject-matter structure in instruction. A "zoom-lens" analogy is presented to facilitate an understanding of the elaboration model of instruction. Some basic concepts and principles upon which the model is based are described. The basic unvarying components of the elaboration model are described. And finally, some variations in the model for different kinds of goals are described. The elaboration model follows a general-to-detailed pattern of sequencing, as opposed to the hierarchically based sequences derived from Gagné-type task analyses.

Introduction

This paper describes a method for sequencing, synthesizing, and summarizing instruction that the authors have been developing for about four years. *Sequencing* refers to decisions about the order in which to present different "topics" of a subject matter (e.g. different concepts and principles) to a student; *synthesizing* refers to ways of showing the interrelationships among those topics; and *summarizing* refers to ways of previewing and reviewing the topics that are taught. Within certain limits, selection of specific topics is also

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of concern herein. Since these aspects of instructional design relate to more than one topic, we refer to them as *macro strategies* (Reigeluth et al., 1978; Reigeluth and Merrill, 1978). Such strategies are distinct from aspects of instructional design which relate to organizing instruction on a single topic (such as the use of matched non-examples, attribute isolation, mnemonics, divergent examples, and feedback on practice), which we refer to as *micro strategies* (Merrill et al., 1979; Reigeluth and Merrill, 1979).

But why are macro strategies important? Synthesizing is extremely important for most kinds of instruction because it makes the parts of the subject matter more meaningful to the student by showing their context (Ausubel, 1963, 1968) – that is, by showing how they fit into a larger picture. A more meaningful understanding has the following advantages: (1) the student will have better long-term retention of those parts; (2) the student will gain an additional kind of knowledge, one that is usually more valuable than segmented information; (3) the student will enjoy the learning more; and (4) the student will have higher motivation to learn the subject-matter content. Another major kind of macro strategy – sequencing – is important because the type of sequence is likely to influence the nature and stability of cognitive structures that a student forms and because all instructional content has learning prerequisites (Gagné, 1968, 1977). And the third major kind of macro strategy – summarizing – is important because systematic preview and review of topics can have an important influence on retention as well as on synthesizing strategies.

There are many important factors that influence the quality of the education a student receives, such as the personality of the teacher or the amount of expensive resources available; but macro strategies are particularly important because (1) they are tools that all teachers and instructional designers can learn to use to reliably improve the amount, quality, and enjoyability of the content that their students learn; and (2) they are inexpensive to implement.

A radically different function for subject-matter structure is described herein. We, like most others, had previously thought of subject-matter structure simply as a framework for designing instructional sequences. We now view subject-matter structure as that plus a lot more: structure should itself be taught – it should be a part of the instruction – in order to teach the important interrelationships within the subject matter.

There are three sections of this paper. In the first, an analogy is presented to facilitate an understanding of the basic aspects of the elaboration model of instruction. Then some basic concepts and principles upon which the model is based are described. And in the last section some more detailed and variable aspects of the model are described.

The elaboration model of instruction, as described herein [1], represents our current, incomplete, and evolving thoughts on macro strategies. Much

work remains to be done to further develop these ideas, to test their validity, and to refine procedures that will make them highly useful to instructional designers and instructors. Therefore, these ideas should in no way be construed as being "set in stone."

An Analogy

In order to understand the nature of the elaboration model of instruction, an analogy may be helpful. Taking a look at a subject matter "through" the elaboration model is similar in many respects to looking at a picture through a zoom lens. A person usually starts with a wide-angle view, which shows the major parts of the picture and the major relationships among those parts (e.g. the composition or balance of the picture), but which lacks much detail.

The person then zooms in on a part of the picture. He/she could be forced to zoom in on a certain part, or he/she could be given the option of zooming in on whatever part interests him/her the most. Assume that, instead of being continuous, the zoom operates in steps or discrete levels. Zooming in on one level on a given part of the picture allows the person to see the major subparts of that part and the major relationships among those subparts. Then the person should zoom back out to the wide-angle view to review the context of that part within the whole picture.

At this point several options are available. The person could zoom back in one level to look at another part of the picture. Or he/she could zoom in on a second level for more detail or complexity on the part that he/she just viewed. Either option should be followed by zooming back out one level for context (i.e. synthesis) and review. Again, the person could be forced to follow a certain pattern; he/she could be given the option of following any of a limited number of types of patterns; or he/she could be given total freedom to follow any pattern he/she chooses, as long as no subpart is inspected before it has been seen from the next-higher level.

After viewing a set of details on a part of the picture (i.e. subparts directly below a given part), the person should always zoom back out to revisit the whole part in order to synthesize that detail – that is, to see, with greater detail and understanding, the relationships among those subparts.

In a similar way [2], the elaboration model of instruction starts the student with a general (but not abstract) view of the subject matter to be taught. Then it divides that subject matter into parts, elaborates on each of those parts, divides those parts into subparts, elaborates on each of those subparts, and so on until the knowledge has reached the desired level of detail and complexity.

This general-to-detailed organization allows the learner to learn at the level of detail that is most meaningful (Ausubel, 1963, 1968) to him/her at any

given state in the development of his/her knowledge. The learner is always aware of the context and importance of the different topics he/she is learning and of the important relationships among the topics that he/she has learned. And the learner never has to struggle through a long series of learning prerequisites that are on too deep a level of detail to be interesting or meaningful at the initial stages of instruction. As he/she works his/her way to deeper levels of detail, increasingly complex prerequisites will need to be introduced. But if they are only introduced at the level of detail at which they are necessary, then there will be only a few prerequisites at each level and the learner will want to learn those prerequisites because he/she will understand their importance for learning at the level of detail that now interests him/her.

Unfortunately, up to now the zoom lens has hardly been used at all in instruction. Most instructional sequences begin with the "lens" zoomed all the way in at one corner of the "picture" and proceed - with the "lens" locked on that level of detail - to systematically cover the entire scene. This has had unfortunate consequences both for synthesis and for motivation.

The lack of utilization of a zoom lens in instruction, in spite of the important pioneering work of Ausubel over two decades ago, may be due in part to Ausubel's complex vocabulary and writing style and to his stress on contributing to the science of learning instead of to the science of instruction. At about the same time, Gagné's hierarchical learning theory was proposed in a much more straightforward manner. Furthermore, Gagné's work was grounded in behavioral psychology, which was in vogue at the time, while Ausubel was espousing cognitive psychology, which was just beginning to catch on. Our own purposes stress the science of instruction rather than the science of learning and are highly consistent with the emerging cognitive psychology, especially information processing theory and schema theory. (For a discussion of the interrelationships of our elaboration model to cognitive psychology, see Merrill [1979].) In spite of a similar overall orientation to instruction, the elaboration model is different from Ausubel's instructional model in some important respects, and the elaboration model is much more detailed with respect to the specification and description of strategy components - the specifics as to how instruction should be designed. The following is a description of some details of the elaboration model of the instruction.

Basic Concepts and Principles

Since a model is comprised of a set of interrelated principles, it may be helpful if we describe the hypothesized principles of instruction comprising the elaboration model. But before we can describe these hypothesized principles, it is necessary to describe several unfamiliar concepts which are parts of some of those principles (see Reigeluth and Merrill, 1979).

CONCEPTS

Content construct: A single fact, concept, principle, or step (of a procedure).

Content construct was referred to above as a single "topic," but "topic" has a broader meaning than does "content construct." For instance, "history" as a topic may be very different from history as a content construct. For more information about this distinction, see Reigeluth et al. (1978).

Subject-matter structure: A set of content constructs that are grouped together on the basis of a single pervasive relationship among them.

A subject-matter structure is very different from a network (Crothers, 1972; Pask, 1975; Shavelson, 1974) in that a network attempts to show more than one kind of relationship among constructs (i.e. facts, concepts, principles, or procedures). It is important to analyze a subject matter as to more than one kind of relationship; but for purposes of designing instruction, it is more valuable to derive many structures, each of which describe only one kind of pervasive relationship. It is also important to teach the student more than one kind of relationship; but we propose that it is better to teach one kind of relationship at a time. This is why it is important to define a structure as that which shows only one kind of pervasive relationship among some constructs (i.e. facts, concepts, principles, or procedures). For a more in-depth discussion of subject-matter structures, see Reigeluth et al. (1978).

Subject-matter structures can be classified as orientation structures or supporting structures (see Fig. 1) which, when combined, form a multi-structure.

Orientation structure: A structure which is highly inclusive in that it subsumes all or most of the subject matter to be taught.

Supporting structure: A structure which is much less inclusive than an orientation structure and is nested either within an orientation structure or within a more inclusive supporting structure. It provides knowledge which supports an understanding of the structure within which it is nested.

Multi-structure: Two or more related structures whose interrelationships are shown. Fig. 1 shows a multi-structure.

An orientation structure may be any of three types: conceptual, procedural, or theoretical; and a supporting structure may be any of those same three types or it may be a learning structure.

Conceptual structure: A structure showing superordinate/coordinate/subordinate relations among constructs. There are three important types of conceptual structures: parts taxonomies, which show constructs that are components of a given construct; kinds taxonomies, which show constructs that are varieties of a given construct; and matrices (or tables), which are combinations of two or more taxonomies. See Figs. 2, 3, and 4 for examples of these three kinds of conceptual structures.

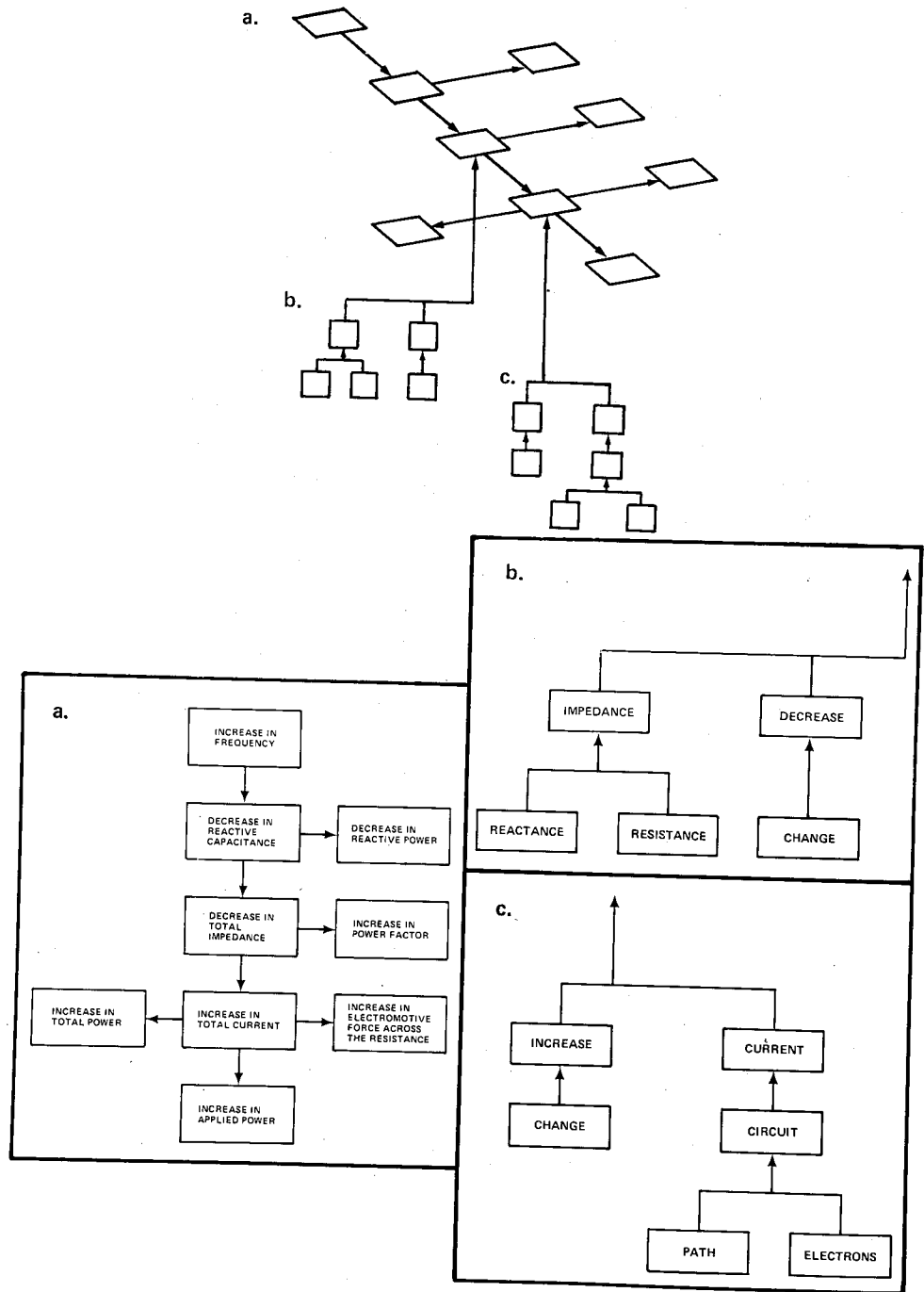
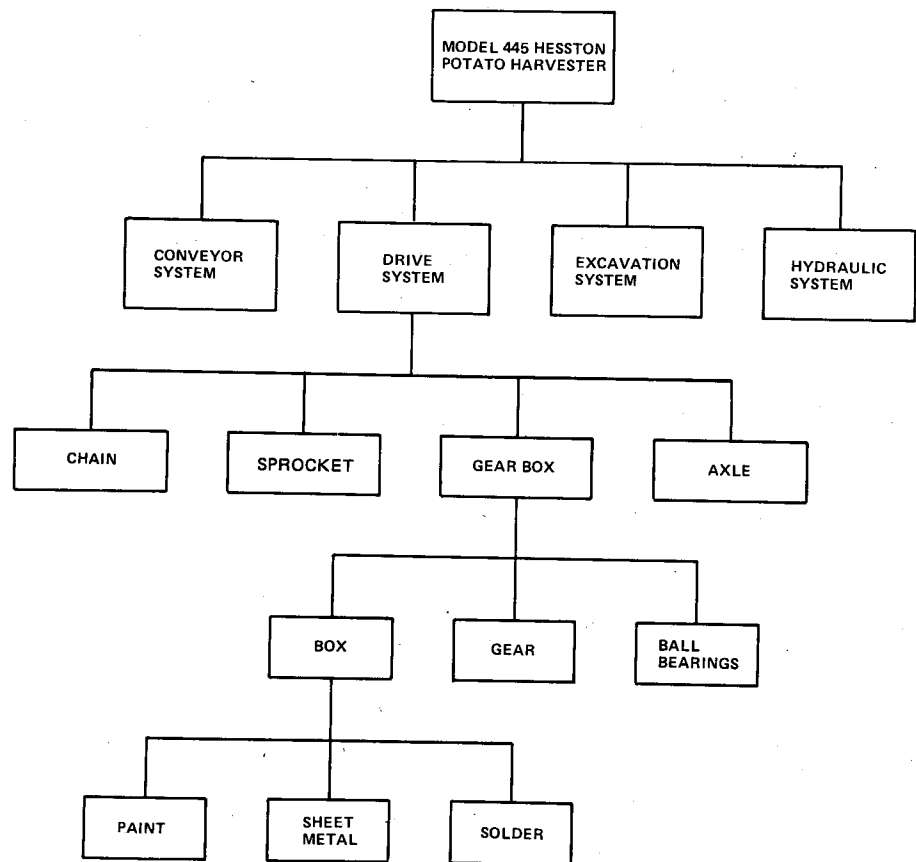


Fig. 1. A multi-structure showing two supporting structures (b and c) and the relationship of each to an orientation structure (a).

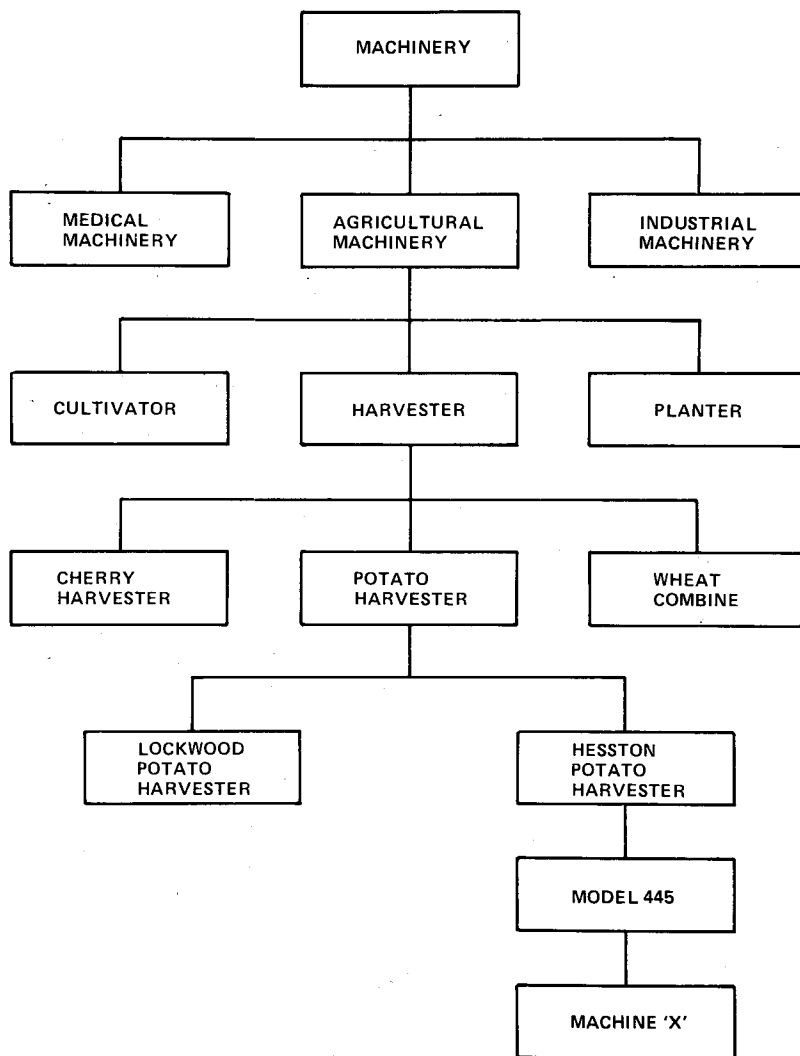
Procedural structure: A structure showing procedural relations among constructs. There are two important kinds of procedural structures: those which show procedural-prerequisite relations, which specify the order(s) for performing the steps of a single procedure, and those which show procedural-decision relations, which describe the factors necessary for deciding which alternative procedure or subprocedure to use in a given situation. See Figs. 5 and 6 for examples.

Theoretical structure: A structure showing change relations among constructs. The most common kind of theoretical structure, or model, is that which shows empirical relations (see Fig. 7). Another important kind is one which shows logical relations (see Fig. 8). One of the major tasks of any discipline is to discover or create logical structures which are isomorphic with empirical structures.



KEY: THE LINE BETWEEN TWO BOXES ON DIFFERENT LEVELS MEANS THAT THE LOWER BOX IS A COMPONENT OF THE HIGHER BOX.

Fig. 2. An example of a parts taxonomy. (Note: it is not complete.)



KEY: THE LINE BETWEEN TWO BOXES ON DIFFERENT LEVELS MEANS THAT THE LOWER BOX IS A VARIETY OF THE HIGHER BOX.

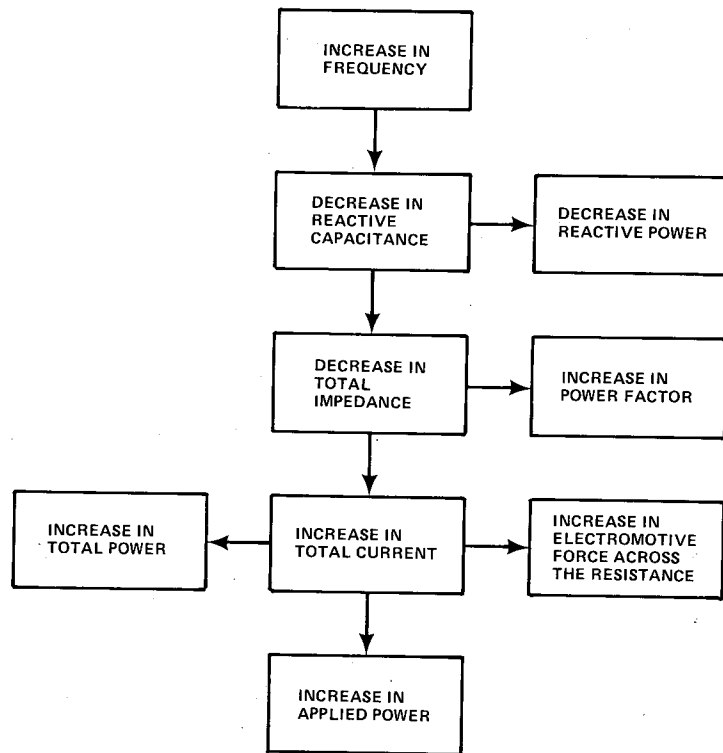
Fig. 3. An example of a kinds taxonomy. (Note: it is not complete.)

SELECTION CRITERIA				METHODS				
Two numerical variables	Linear association	Scores used on X or Y or both			1	PEARSON r $r = \frac{N\sum XY - \sum X\sum Y}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$		
		Ranks used on both X and Y	Most common measure for ranks (r_s)	No ties on X or on Y	Easiest formula for hand calculation	2	SPEARMAN r_s $r_s = 1 - \frac{\sum d^2}{6(N^2 - N)}$ d = difference between ranks	
				Easiest formula for machine calculation		2a	r_s FOR MACHINE X and Y are ranks $r_s = \frac{3}{N-1} \left[\frac{\sum XY}{N(N+1)} - (N+1) \right]$	
			Ties on X or Y		2b	r_s WITH TIES See Method Outline		
			Measures which are very similar to r_s	Ties on X or on Y	None	3	KENDALL TAU (τ) See Method Outline	
		Few			3a	τ WITH TIES See Method Outline		
		Nontlinear association		Simple method			Draw scatterplot	
				More exact method			See Method 6	
		A numerical variable (scores or ranks) correlated with a categorical variable	Two Categories	Scores	Have within-category means and standard deviations been computed?	No	4	POINT BISERIAL r $r_{pb} = \frac{M_2 - M_1}{S} \times \sqrt{\frac{n_1 n_2}{N(N-1)}}$
					Yes	4a	$S = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2 + \frac{n_1 n_2}{N}(M_1 - M_2)^2}{N-1}}$ Enter this value of S into method 4.	
Ranks	OD curve not drawn			5	GLASS RANK - BISERIAL CORRELATION M_1, M_2 are within-group mean ranks $r_g = \frac{2}{N}(M_2 - M_1)$			
	OD curve drawn			5a	$r_g = 1 - 2$ (proportion of area under OD curve)			
Three or more categories				6			CORRELATION RATION (η^2) See Method Outline	
Two categorical variables	X and Y both dichotomous	---at the same level?	Formula using frequencies		7	PHI $r_\phi = \frac{AD - BC}{\sqrt{(A+B)(C+D)(A+C)(B+D)}}$		
			Formula using marginal proportions		7a	PHI USING MARGINAL PROPORTIONS $r_\phi = \frac{p_{xy} - p_x p_y}{\sqrt{p_x q_x p_y q_y}}$		
		--- or at different levels?		8		YULE r_q $r_q = \frac{AD - BC}{AD + BC}$		

Fig. 6. An example of a procedural-decision structure. (Adapted from Darlington, R. B., *Radicals and Squares: Statistical Methods for the Behavioral Sciences*, Ithaca, NY: Logan Hill Press, 1975.)

Learning structure. A structure showing learning-prerequisite relations among its constructs (e.g. it shows the critical components of principles – which are concepts – it shows the critical components or attributes of those concepts – which are also usually concepts – and so on). These are often referred to as learning hierarchies (Gagné, 1968), but other kinds of structures (e.g. parts-taxonomic structures and procedural prerequisite structures) are often confused with learning hierarchies. See Fig. 9 for an example.

The following two concepts are important strategy components related to the elaboration model of instruction.



KEY: THE ARROW BETWEEN TWO BOXES MEANS THAT THE CHANGE IN ONE BOX CAUSES THE CHANGE IN THE OTHER BOX TO OCCUR.

Fig. 7. An example of an empirical-theoretical structure.

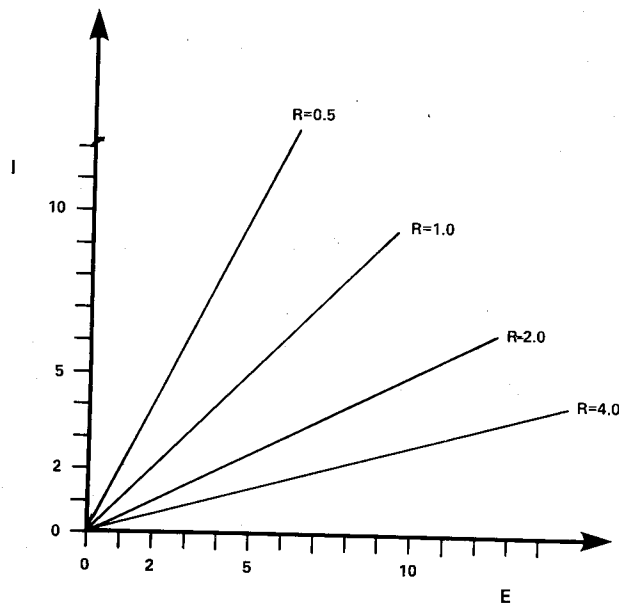
Epitome (ē.pīt'ō.mē): An overview or advance organizer which epitomizes the subject-matter content to be taught in a course rather than summarizing it. It is formed by "boiling down" the course content to its essence. An epitome is a kind of overview, but unlike other overviews and summaries, an epitome includes very few constructs, and it presents them on an application level (with lots of examples and practice, as well as generalities). An epitome is derived from an orientation structure – it portrays only the most important aspects of the orientation structure (and any necessary supporting structures). For example, for a procedural orientation structure, the epitome would be a very simplified procedure (i.e., the shortest path) that subsumes all of the more detailed and complex procedures which the student needs to learn (see Fig. 10).

Elaboration: A portion of instruction which provides more detailed or complex knowledge about a part of the content to be taught. A primary-level

elaboration elaborates on a part of the epitome; a secondary-level elaboration elaborates on a part of a primary-level elaboration; and so on.

$$R = \frac{E}{I}$$

KEY: THE MATHEMATICAL SYMBOLS SHOW THE LOGICAL-THEORETICAL RELATIONS BETWEEN RESISTANCE (R), ELECTROMOTIVE FORCE (E) AND CURRENT (I) IN A SIMPLE SERIES DC CIRCUIT. EMPIRICALLY DETERMINED VALUES MAY VARY SLIGHTLY FROM THE LOGICAL.



KEY: THE LINES ON THE GRAPH SHOW THE RELATIONSHIP BETWEEN CHANGES IN E AND I FOR GIVEN VALUES OF R.

Fig. 8. Two representations of a logical-theoretical structure.

PRINCIPLES

With these concepts in mind, here are some hypothesized principles which we believe to be valid for sequencing, synthesizing, and summarizing subject-matter content (Reigeluth and Merrill, 1978). These hypothesized principles are likely to be valid only for instruction on a fairly large amount of subject matter (e.g. for instruction on many interrelated constructs). For instruction on a fairly small number of constructs, sequencing, synthesizing, and summarizing strategies probably do not make much difference. In effect, the following eight hypothesized principles are parts of a more general "elaboration

principle"; and each of these eight could in turn be broken down into more specific parts, more detailed principles.

(1) *Initial synthesis principle*. An epitome should be presented at the very beginning of the instruction. ("Should" means that doing so will result in the instruction being more effective, efficient, and appealing.)

(2) *Gradual elaboration principle*. Aspects of the epitome should be gradually elaborated on so that the sequence of the instruction proceeds from general to detailed or from simple to complex.

(3) *Introductory familiarizer principle*. A "familiarizer" (e.g. an analogy that serves to relate what is about to be learned to something similar that the learner already knows) should be provided at the beginning of the epitome and at the beginning of each elaboration. (Note: an earlier familiarizer may merely be extended for a later elaboration, or a completely different familiarizer may be used.)

(4) *"Most important first" principle*. Whatever one judges to be the most "important" aspect of the remaining orientation content should be elaborated on first. Importance is estimated by a subject-matter expert on the basis of contribution to the student's understanding of the whole "picture." The rationale for this postulate is that this will result in more meaningful learning, with its attendant increase in motivation, transfer, and long-term retention. If two parts of the epitome are judged to be equal with respect to this criterion of importance, then the subject-matter expert should use such criteria as frequency of use in the real world or the seriousness of the consequences of inadequate use in the real world. The rationale here is that the sooner a part of an epitome is elaborated the better it will be learned, because the learner will gain more practice in doing and integrating that part by the end of the instruction.

(5) *Optimal size principle*. Each elaboration should be short enough that its constructs (i.e. facts, concepts, procedures, and principles) can be recognized comfortably by the student and synthesized comfortably by the instruction, yet long enough that it provides a good amount of depth and breadth of elaboration. This optimal size is related to the limits of short-term memory; but it is also likely that it is influenced by cognitive processing abilities (which are a function of mental maturity) and by certain subject-matter characteristics (such as the novelty of the constructs, the degree of abstractness of the constructs, and the type of relation being synthesized). This is an important area for future research.

(6) *Periodic synthesis principle*. A synthesizer (e.g. a subject-matter structure) should be provided after each elaboration, in order to teach the relations among the more detailed constructs that were just taught and to show the context of the elaboration within the epitome.

(7) *Periodic summary principle*. A summarizer (i.e. a concise generality for each construct) should be provided before each synthesizer. This will facilitate synthesis.

(8) *Type of synthesizer principle.* The following types of synthesizers should be used under the indicated conditions: a conceptual structure (taxonomic or matrix) for conceptual content, a theoretical structure for theoretical content, and a procedural structure for procedural content.

The Elaboration Model

Models show how things work. One can conceptualize models as being of two kinds: (1) descriptive models, which describe natural phenomena and are invariant, and (2) prescriptive models, which describe ways to achieve some end and therefore vary as goals vary. This distinction parallels the difference between descriptive sciences, such as the science of learning, and prescriptive sciences, such as the science of instruction (Reigeluth et al., 1978; Simon, 1969; Snelbecker, 1974). The elaboration model of instruction is prescriptive; it prescribes ways to achieve given goals.

One could conceptualize two aspects of goals of instruction. One aspect is the nature of the general goals of a course of instruction. These general goals could be classified as effectiveness, efficiency, and appeal; and they are fairly uniform for all instruction – that is, one wants the student to learn what is taught (effectiveness), one wants the student to achieve a given level of learning with a minimum of student time (efficiency), and one wants the student to enjoy the instruction (appeal). Since these goals do not vary much from course to course, the model does not vary with respect to these ends; it assumes all three should always be maximized.

The other aspect of goals of instruction is the nature of the orientation goals of a given course. These orientation goals could be classified as conceptual, procedural, or theoretical in orientation (see above). Since the kind of orientation varies from course to course, the model must vary with this kind of goal.

In the next section we will describe the aspects of the model which do not vary from course to course. Then in the following section we will describe aspects which do vary from course to course.

UNVARYING COMPONENTS OF THE MODEL

Keeping in mind the foregoing analogy of the zoom lens, the following is a general description of the elaboration model of instruction (see Fig. 11). The technical terms used herein are defined in the previous section on concepts. (For an earlier version of this model, see Merrill [1977].)

(1) The instruction begins with an *epitome*, which provides an overview of the subject matter by teaching the most important content constructs in the orientation structure and by teaching the supporting structures related to

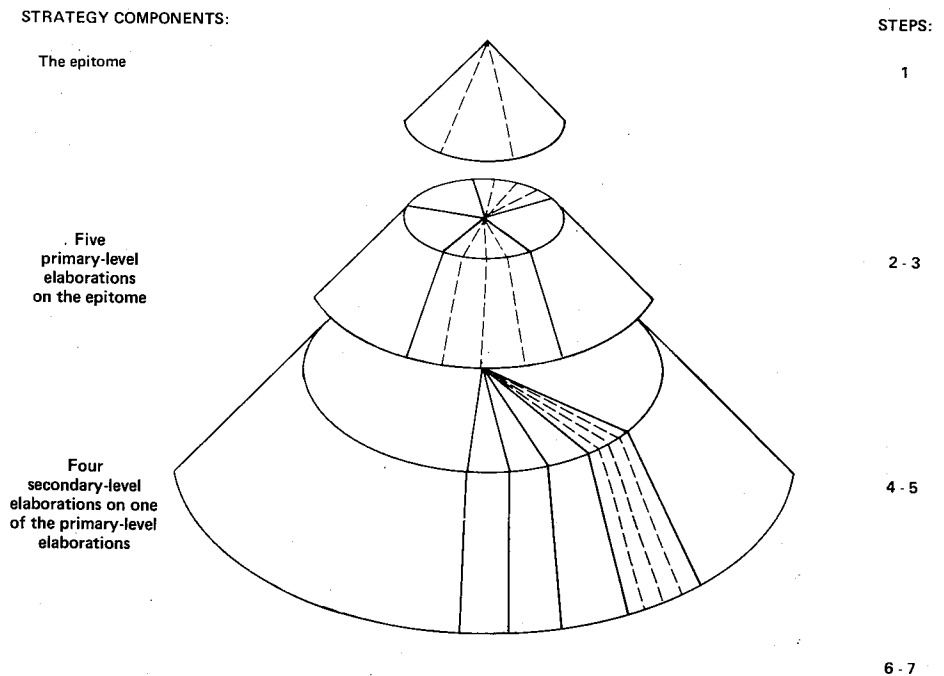


Fig. 11. The major conceptual relationships between the parts of the elaboration model of instruction.

those constructs. This epitome starts with a familiarizer which relates what is about to be learned to something similar that the student already knows.

(2) The instruction provides a *primary-level elaboration* on each aspect of the epitome, beginning with the most "important" aspect. Importance is estimated by a subject-matter expert on the basis of such factors as contribution to understanding the whole picture, frequency of use, or seriousness of consequences of a mistake. Each primary-level elaboration adds detail or complexity to the general understanding of each aspect of the epitome by elaborating on the next most important aspect of the orientation structure and by presenting the supporting structures related to that aspect. At the beginning of each primary-level elaboration, a familiarizer is provided to relate what is about to be learned to something similar that the student already knows.

(3) At the end of each primary-level elaboration, the instruction provides a *summarizer* followed by an *expanded epitome* (an external synthesizer). The summarizer gives a concise generality of each construct that was taught in the elaboration, and the expanded epitome shows (a) the important relationships among the parts of the elaboration and (b) the relationship of the elaborated parts to the (expanding) epitome of the orientation structure.

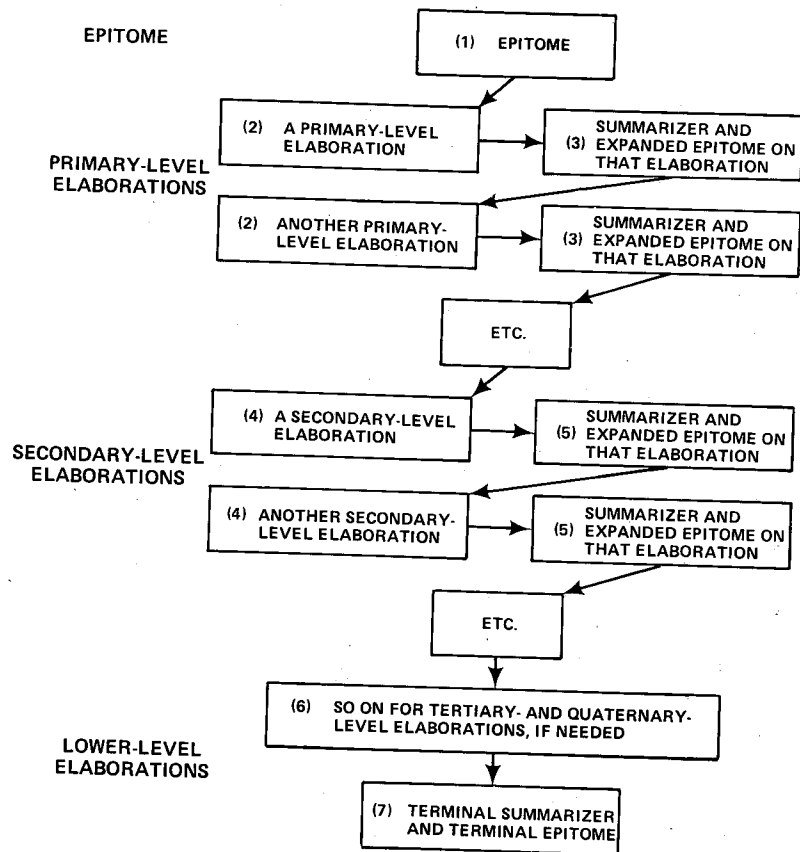


Fig. 12. An epitome of the elaboration model of instruction.

(4) After all of the primary-level elaborations have been presented and integrated with the ever-expanding epitome of the orientation structure (see Fig. 12), the instruction presents *secondary-level elaborations* – which elaborate on each primary-level elaboration rather than on the epitome – if such is necessary to bring the student to the depth of understanding specified by the objectives of the instruction. Like its primary-level counterpart, each secondary-level elaboration is initiated with a familiarizer.

(5) At the end of each secondary-level elaboration, the instruction provides a summarizer and an expanded epitome, similar to those at the end of each primary-level elaboration.

(6) After all of the secondary-level elaborations have been presented, synthesized, and integrated into the expanded epitome, then the pattern is repeated for *tertiary-level elaborations*, *quaternary-level elaborations*, etc., if such are needed to bring the student to the depth of understanding specified by the objectives of the instruction.

(7) At the very end of the instruction, a *terminal epitome* is presented to synthesize the entire domain of the subject matter. This terminal epitome is not merely an extended review of each of the content constructs. Rather, it is a final articulation of the structure of the content; it reviews the relationships taught and integrates the various layers of elaborated content.

VARIATIONS OF THE MODEL

There are many possible variations of this model. In reference to the zoom-lens analogy, the instruction could zoom in on just one primary-level elaboration before zooming in on its secondary-level elaborations, rather than zooming in on all primary-level elaborations before zooming in on any secondary-level elaborations. Or the learner could be given control over the sequencing of elaborations (Reigeluth, 1979). However, we hypothesize that the most cost-effective variation is the one that was just described in some detail and, was illustrated in Fig. 12.

Assuming that the most cost-effective variation were known, it is likely that the above-described aspects of the model would not vary from course to course – that is, the instructional components described would always all be present and in the same order. However, there are two ways in which this model may systematically vary from one kind of course to another.

First, the nature of the major strategy components described varies with the type of orientation goal. Although their presence and their order would probably not change, the epitome, the elaborations, and the synthesizers all vary considerably depending upon whether the orientation goals are conceptual, procedural, or theoretical. Below is a description of those variations and when each should be used.

The second way in which this model may vary from one course to another is that the epitome, elaborations, and synthesizers are usually based on a number of interrelated structures (i.e. a multi-structure) rather than on a single structure. These variations are also briefly described below.

Epitome

The nature of the epitome and the procedures for creating it are different for each type of orientation goal: conceptual, procedural, or theoretical. The procedures for creating the epitome will be described in some detail in a forthcoming book by the authors and are beyond the scope of this paper. The following is a description of the nature of the epitome for each type of orientation goal.

Conceptual. Like all epitomes, a conceptual epitome has two major parts: a synthesizer, and the instruction necessary to understand that synthesizer. The synthesizer in this case is a conceptual structure, but this synthesizer must be a very simple or general version of the conceptual orientation structure, and it must subsume the majority of the subject matter that is to be taught. It

		KINDS OF THEMES							
		DESCRIPTION & NARRATION	EVALUATION & INTERPRETATION	ANALYSIS	DEFINITION & CLASSIFICATION	CAUSE & EFFECT	COMPARISON & CONTRAST	CON/PRO ARGUMENT	ANALYSIS OF A COMPLEX IDEA
PARTS OF A THEME	WHOLE THEME								
	PARAGRAPH								
	SENTENCE								
	WORD								
	MECHANICS								

Fig. 13. A matrix structure as a conceptual-epitome synthesizer for a course in English composition.

should contain the maximum amount of material that a student can learn comfortably in one lesson (e.g. in perhaps a one-hour sitting). Generally, it is the top portion of the taxonomy (or, in the case of a matrix, it is the top portion of the taxonomies that comprise the matrix). Such a conceptual synthesizer is shown in Fig. 13.

The instruction necessary for the student to understand the epitome's synthesizer will usually include generalities, instances, and practice on each concept and on the relations portrayed in the synthesizer (see Merrill et al., 1979). The instances and practice do not have to be abstract; in fact, they should be concrete, real-life cases. But they should be chosen or generated so as to be simple enough for the student to be able to learn at the initial stages of the instruction. In order to teach each concept in the synthesizer, it may be necessary to identify its learning prerequisites, and to include them in the instruction if they cannot be assumed as entering knowledge of the students.

Procedural. A procedural epitome is also comprised of a synthesizer and the instruction necessary to understand that synthesizer. In this case the synthesizer is a procedural structure (either procedural-prerequisite or procedural-decision). Again it must be a very simple or general version of the complete procedural orientation structure, and it must subsume the majority of the subject matter that is to be taught. Aside from its being a different kind of structure, the major difference between this and a conceptual-epitome

synthesizer is that this kind of synthesizer cannot be formed merely by “pruning” off a part of the orientation structure; rather a more simple but parallel procedural structure needs to be created (see Reigeluth and Rodgers, 1980). Such a simplified procedural synthesizer is shown in Fig. 10 above.

The instruction necessary for understanding the epitome’s synthesizer will include generality–instances–practice instruction (see Merrill et al., 1979) on each step (construct) and on the relation portrayed in the synthesizer. The instances and practice should be real-life cases that are chosen or generated so as to be simple enough for the student to learn at the initial stages of the instruction. For example, in reference to Fig. 10, the method of statistical analysis may be an extremely simple one having only a few steps, or it may be a complicated procedure that can be simplified by providing inputs that reduce it to just a few steps. For all steps which involve concept classification, those concepts will need to be taught (if they are not entering knowledge of the students); and their learning prerequisites may need to be identified and included in the instruction (if they cannot be assumed as entering knowledge of the students).

Theoretical. A theoretical epitome is also comprised of a synthesizer and of the instruction necessary to understand it. In this case the synthesizer is a theoretical structure (either empirical or logical). Again it must be a very simple or general version of the complete theoretical orientation structure, and

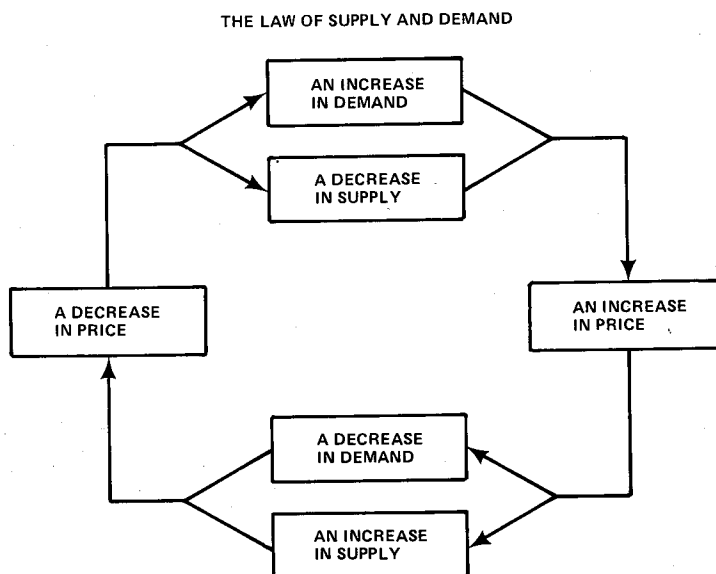


Fig. 14. A simplified/generalized theoretical structure as a theoretical-epitome synthesizer for an introductory course in economics.

it must subsume the majority of the subject matter to be taught. Sometimes this kind of synthesizer can be formed by merely "pruning" off a part of the orientation structure (as for the conceptual epitome), but sometimes a simple/generalized parallel structure must be created (as for the procedural epitome). In either case, the historical development of the principles and theories in a subject matter often provides an excellent pattern for deriving the epitome synthesizer and its subsequent elaborations (see below). Such a simplified/generalized theoretical synthesizer is shown in Fig. 14.

The instruction necessary for understanding the epitome's synthesizer will include generalities, instances, and practice on each construct and on the theoretical relations in that synthesizer (see Merrill et al., 1979). Again the instances and practice should be real-life cases that are on a simplified level. (For example, in reference to Fig. 14, the student should be shown actual instances of the effects of changes in demand on changes in price.) The theoretical structure is comprised primarily of concepts, and therefore their learning prerequisites may also need to be identified and included in the instruction.

Expanded Epitomes

The expanded epitomes are basically the same as the epitome synthesizer for each type of orientation goal (conceptual, procedural, and theoretical), except that they are synthesizers which are correspondingly extended to include more complexity or detail.

Elaborations

The nature of the elaborations and of the procedures for creating them are also different for each type of orientation goal: conceptual, procedural, or theoretical. The procedure for creating the elaborations will be described in some detail in our forthcoming book and is beyond the scope of this paper. The following is a description of the nature of the elaborations for each type of orientation goal.

Conceptual. Like all elaborations, the conceptual elaborations gradually lead the student from a very general understanding of the subject matter to be taught (i.e. from the epitome or the wide-angle view) to the level of complexity or detail specified by the objectives. In this case, each elaboration teaches concepts which are subordinate to a general concept that has already been taught, either in the epitome (for primary-level elaborations) or in an elaboration (for lower-level elaborations). In other words, the topics of an elaboration are the parts or kinds (depending upon the type of conceptual structure) of a general concept or concepts. Each elaboration may also include the content of one or more supporting structures.

Regardless of the type of elaboration (conceptual, procedural, or theoretical), the amount of material within each elaboration must be gauged to

the ability level of the learners. If there is too much material, it will be too difficult for the student to synthesize (due to an excessive memory and assimilation load), and the student will be less motivated (due to a greater difficulty in keeping the whole "picture" in mind). In an introductory course for graduate students, much more material should be included in each elaboration than in an introductory course for junior high school students. The amount of material in an elaboration may be adjusted either by changing the breadth of the elaboration or by changing the depth of the elaboration. For fairly simple material, a single elaboration could include an entire row of a taxonomy or of a matrix, or it could entail going three levels deep on a single box in the epitome. Specific recommendations are included in our forthcoming book.

Procedural. Each procedural elaboration provides its detail or complexity on a single step of the procedural epitome, or by adding an alternate path (see e.g. P. Merrill, 1978). Therefore, the amount of material within an elaboration should be adjusted only by changing the depth of the elaboration (with the exception that two steps of the epitome could be included in an elaboration if they both have little depth, or two alternative paths could be added if they both have little depth). This is the most important difference from the conceptual elaboration.

Theoretical. Each theoretical elaboration provides its complexity by teaching principles that are successively more local, detailed, and complex. These elaborative principles usually relate to a single aspect of the elementary model in the epitome. As with the procedural elaboration, the amount of material within a theoretical elaboration can usually be adjusted only by changing the depth of the elaboration (but again, two aspects of the elementary model could be included in an elaboration if they both have little depth). Many textbooks which follow the historical development of a discipline come fairly close to this paradigm of instructional organization.

Internal Synthesizers

The internal synthesizers in each elaboration are very similar to the synthesizer which is part of the epitome. The major difference is its scope: it synthesizes only the constructs that comprise one supporting structure in the elaboration, and it does not show the context of those constructs within the larger picture.

Conceptual. A conceptual internal synthesizer is a conceptual structure that shows super/co/subordinate relations among its concepts. It may show parts-ordinate relations, kinds-ordinate relations, or both. Usually this internal synthesizer is just a few levels of a conceptual structure.

Procedural. A procedural internal synthesizer is a procedural structure that shows the order relations among its event concepts (steps). It may show either procedural-prerequisite relations or procedural-decision relations. This internal synthesizer is usually a relatively small procedure.

Theoretical. A theoretical internal synthesizer is a theoretical structure that shows the theoretical relations (usually causal) among its constructs. It may show either logical or empirical theoretical relations. And this synthesizer is usually a small model or a part of a larger theoretical structure.

Multi-Structures

We mentioned above that the epitomes, elaborations, and synthesizers comprising a course are usually based on a number of interrelated structures rather than on a single structure. We refer to such a set of interrelated structures as a multi-structure. In the section on epitomes, it was indicated that learning structures may be needed in the design of the instruction on the epitome synthesizer, in order to teach the learning prerequisites for each concept comprising the epitome synthesizer. But learning structures are not the only kind of structure that can be nested within an orientation structure in an epitome or an elaboration.

Given, say, a theoretical orientation structure, the nature of the goals of the course may call for teaching certain efficient procedures associated with different parts of the theory or model. In such a case, procedural structures would be nested within the theoretical orientation structure, and some of the elaborations would elaborate on procedures rather than on parts of the theory or model. Similarly, some internal synthesizers would be procedural and some expanded epitomes would be multi-structural.

Summary

In this paper we have described an instructional model for sequencing, synthesizing, and summarizing subject-matter content. The importance of such macro strategies was discussed, and it was emphasized that the elaboration model of instruction represents a significant change in the role of subject-matter structure in instruction.

First, the zoom-lens analogy was presented to facilitate an understanding of the nature of the elaboration model of instruction. A student starts with a wide-angle view of the subject matter and proceeds to zoom in for more detail on each part of that wide-angle view, zooming back out for context and synthesis. In some cases, it may be best for a learner to pan across the entire subject matter on one level before zooming in for more detail on any part, whereas in other contexts it may be best for the learner to continue to zoom in all the way on one area before zooming in at all on any of the other areas. In still other contexts, it may be best to let the student follow his/her interests, as long as he/she uses a zoom-in pattern rather than a zoom-out pattern.

Second, some basic concepts and principles upon which the elaboration model is based were described. The concepts were: content construct, subject-

matter structure, orientation structure, supporting structure, multi-structure, conceptual structure, procedural structure, theoretical structure, learning structure, epitome, and elaboration. The hypothesized principles were: (1) the initial synthesis principle, (2) the gradual elaboration principle, (3) the introductory familiarizer principle, (4) the "most important first" principle, (5) the optimal size principle, (6) the periodic synthesis principle, (7) the periodic summary principle, and (8) the type of synthesizer principle.

Third, we distinguished between two kinds of models and expressed the need for a model which describes ways to achieve some end in instruction. Since general goals (ends) – such as effectiveness, efficiency, and appeal – do not vary much from course to course, the elaboration model of instruction is fairly constant in aspects related to these goals. But since orientation goals (ends) – such as conceptual, procedural, or theoretical orientations – *do* vary from course to course, the elaboration model varies from course to course with respect to aspects related to these goals. This conceptual/procedural/theoretical distinction is one of the most important advances of the elaboration model.

Fourth, the basic unvarying components of the elaboration model of instruction were described: an epitome, the primary-level elaborations, the summarizer and expanded epitome following each primary-level elaboration, the secondary-level elaborations, the summarizer and expanded epitome following each secondary-level elaboration, and the terminal epitome summarizing the entire course – both its constructs and its relations.

Fifth and finally, we described the variations of the elaboration model for different courses. Some different patterns of sequencing, including learner control, were briefly mentioned. Then the nature of the epitome, the expanded epitome, the elaborations, and the internal synthesizers were described for each kind of orientation: conceptual, procedural, and theoretical. And finally, we discussed the use of diverse multi-structures as a basis from which to design and organize the instruction.

Notes

- 1 A more general, introductory description of the elaboration model (written after this article) has since appeared: Reigeluth (1979); see also Reigeluth and Rodgers (1980).
- 2 It must be remembered that the zoom-lens analogy is just an analogy and therefore that it has non-analogous aspects. One such dissimilarity is that all the detail of the picture is actually present (although usually not noticed) in the wide-angle view, whereas the detail is not there at all in the epitome. Also, detail is added in discrete steps in the elaboration model.

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