The Elaboration Theory of Instruction: Prescriptions for Task Analysis and Design

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The Elaboration Theory is an attempt to integrate much of the piecemeal (and sometimes apparently conflicting) knowledge about how best to analyze tasks and/or content for purposes of designing instruction. Two insights have arisen from this attempt at integration. First, task and/or content analysis should not be divorced from design considerations (where design refers to the selection of strategies or methods of instruction). The way task and/or content analysis is done should be determined by what knowledge is needed about the task/content in order to select the best strategies (i.e., to design optimal instruction). Second, in our attempt to integrate knowledge in this area it became evident that there are important gaps in our knowledge. Hence, a considerable amount of effort in the development of the Elaboration Theory went into the generation of "new" knowledge—including strategies and prescriptive principles of instruction.

Two recent articles are available on Elaboration Theory: a fairly technical, detailed explanation based on the Final Reports of two projects to develop the theory (Reigeluth, M. D. Merrill, Wilson, & Spiller, in press) and a general introduction to the theory (Reigeluth, 1979). This article, however, focuses on some procedures for actually doing a task analysis and designing instruction according to the Elaboration Theory. In keeping with the first insight mentioned above, we will describe a single integrated set of procedures for both *analysis* and *design*.

The General Model

Before we begin to describe how to analyze and design instruction according to the Elaboration Theory, it may be helpful to present a brief introduction to what instruction is like once it has been designed and developed according to the theory. To understand what ET-designed instruction will look like, it may be helpful to use an analogy. Imagine looking at a picture through a zoom lens. The instruction begins with the *wide-angle view*, which shows only the major parts of the picture and their interrelationships. There is little detail. You can gradually increase the detail and complexity of the parts which particularly interest you by *zooming in* on them. Assume that the zoom operates in discrete levels rather than being continuous. After zooming in one level on one part of the picture, you must zoom back out to integrate that information with the larger whole and to review previous instruction. Then you can go back and zoom in to a second level on the same part, this time seeing even greater complexity and detail. Or instead you could zoom in to the first level on a different part. This pattern of zooming in for detail and complexity followed by zooming out for review and synthesis can be learne controlled (to follow one's interests or it can be system (e.g., teache controlled, or some combination the two.

The way task and/or content analysis is done should be determined by what knowledge is needed about the task/content in order to select the best strategies.

This method of instruction has number of advantages over sequen ing based on other analysis and/ design models. Perhaps the mo important advantage is the enhance achievement, retention, transfer, an motivation that occur when a sul sumptive sequence is followed (A subel, 1963, 1964, 1968; Maye 1979). Another important advanta is that obtained when students a able to perform a version of the te minal behavior early in the instru tional process. You thereby avoid th demotivating influence of masterin only discrete components before th end of the instruction. Furthermor the increased control over what t study (if desired by the instructo may enhance interest and motivatio (Deci, 1975). Finally, the systemati review and explicit synthesis what has been taught have importa influences on achievement, rete tion, transfer, and motivation, a well as providing a kind of know edge that is all too frequently lac ing.

Content Types

One important way in which th Elaboration Theory extends previou knowledge is that it hypothesize that the instruction will be better the process of zooming in (elabora ing) is based on a *single type of con tent*. Aside from rote facts, there a three fundamental types of conten concepts, principles, and procedure (M.D. Merrill, Richards, Schmidt Wood, 1977; Reigeluth & M.D. Me rill, 1978). A concept is a set of ob

jects, events, or ideas that share certain characteristics. A principle (or proposition) is a change relationship, usually a cause-and-effect relationship. And a procedure (or technique, method, skill) is an ordered set of actions for achieving a predetermined goal (or task). Note, therefore, that "tasks" are made up of procedures, which are a type of content. Hence "task analysis" is a type of content analysis—one that just involves the analysis of procedural content.

Elaboration Theory has extended this distinction among the three major types of content to three major *types of relationships* in subject matter: conceptual, theoretical, and procedural (Reigeluth & M. D. Merrill, 1978; Reigeluth, M. D. Merrill, & Bunderson, 1978). Conceptual relationships are superordinate/subordinate/coordinate relationships in which the subordinate concept is either a part or a kind of the superordinate concept. Theoretical relationships are interrelated chains of principles, which are usually called theories or theoretical models. And procedural relationships are interrelated chains of procedures, which are often called tasks or procedures.

As we mentioned above, Elaboration Theory prescribes that the elaborative sequencing of the content (the zooming-in process) should be based on just *one* of these three types of content relationships. The decision as to which type of "organizing content" to use is made by the designer and the subject matter expert jointly, based on the goals of the course. The major sequencing of the course is then designed on the basis of that type of content.

To the best of our knowledge, *all* subjects include all three types of content and relationships, and therefore *all* subjects can be sequenced by *any* of these three methods. For instance, the goals of a course in English Composition might emphasize concepts: kinds of compositions and parts of compositions. Or they might emphasize procedures: how to write good compositions. Or they might emphasize principles: ways in which certain factors influence the effects or quality of a composition. Even when all three types of content are important, however, the goals of the course usually provide sufficient basis for selecting *one* which will receive primary emphasis. The other two types of content then provide support for the organizing content when necessary and appropriate.

Epitomizing

Another important way in which the Elaboration Theory extends previous knowledge is that it hypothesizes that the instruction will be better if the wide-angle view *epitomizes* the organizing content rather than *summarizing* it. Epitomizing differs from summarizing in two important ways: epitomizing involves teaching a *small number* of concepts (or principles, or procedures) at the *"application" level* (referred to as the "using-a-generality" level by M. D. Merrill), whereas summarizing involves touching lightly on a large number of concepts (or principles, or procedures) at an abstract recall level (referred to as the "remembering-a-generality" level by M. D. Merrill). Epitomizing will be further clarified below.

The Design Procedure

This has been a necessarily brief explanation of the form that instruction takes when it is designed according to the Elaboration Theory. The next section of this article is devoted to the procedures for designing instruction according to the Elaboration Theory. Due to space limitations, we will only be able to present the procedure for designing instruction for one type of organizing content. Since task analysis refers to procedural content and since procedural goals probably predominate the courses that *NSPI Journal* readers design, we will use the procedural organization. In order to provide an extra example of Elaboration Theory in action, we will teach the design procedure using the Elaboration Theory.

However, before we begin it is important to reemphasize that ET's design prescriptions are based on the following assumptions regarding how to maximize achievement, long-term retention, transfer, and motivation: (1) the instruction should begin with procedures that are at a low level of complexity, (2) the instruction should allow for early application of the procedures to realistic cases, (3) the instruction should be sequenced by gradually adding more complex procedures, (4) the instruction should require systematic review and synthesis by periodically integrating the most recent learning with earlier learning, and (5) the instruction should require mastery of one level of complexity before additional complexity is introduced to it.

EPITOME

Introduction

There are five important steps for analysis and design according to the Elaboration Theory:

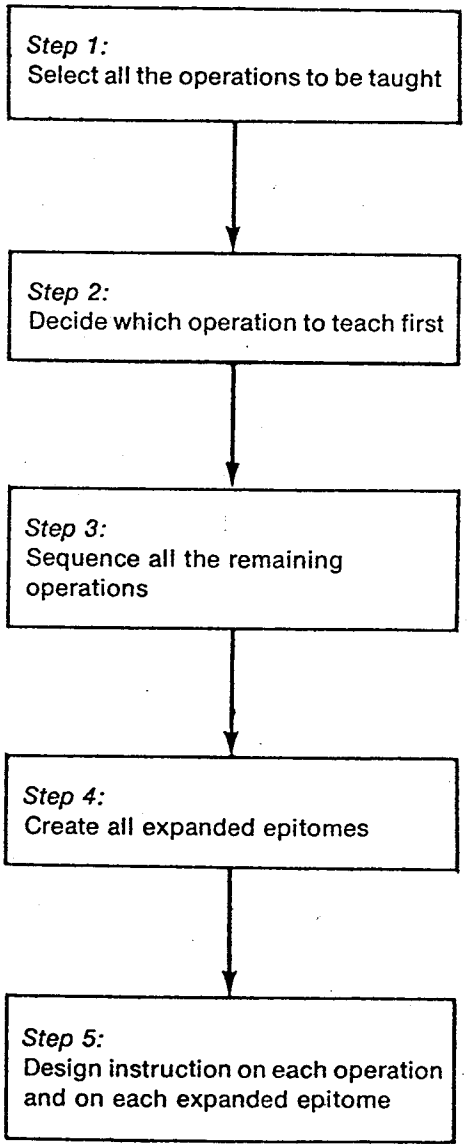


Figure 1.

Step 1. Select All the Operations

Generality—What you should do.

Conduct an *information processing task analysis.* (We assume that this is entering knowledge for the reader. See P. Merrill [1976, 1978] if you need to brush up on this prerequisite.) The result of this process will be a task description: a list of all the operations the learner must perform in order to succeed in the terminal task.

Example

We have chosen subtraction of whole numbers to illustrate the ET design procedure because it has been used by Gagné and Briggs (1974), P. Merrill (1976, 1978), and Scandura (1973), and thus can serve a comparative function. The flow chart below shows the result of step 1: conduct an information processing task analysis to select all the operations that are to be taught.

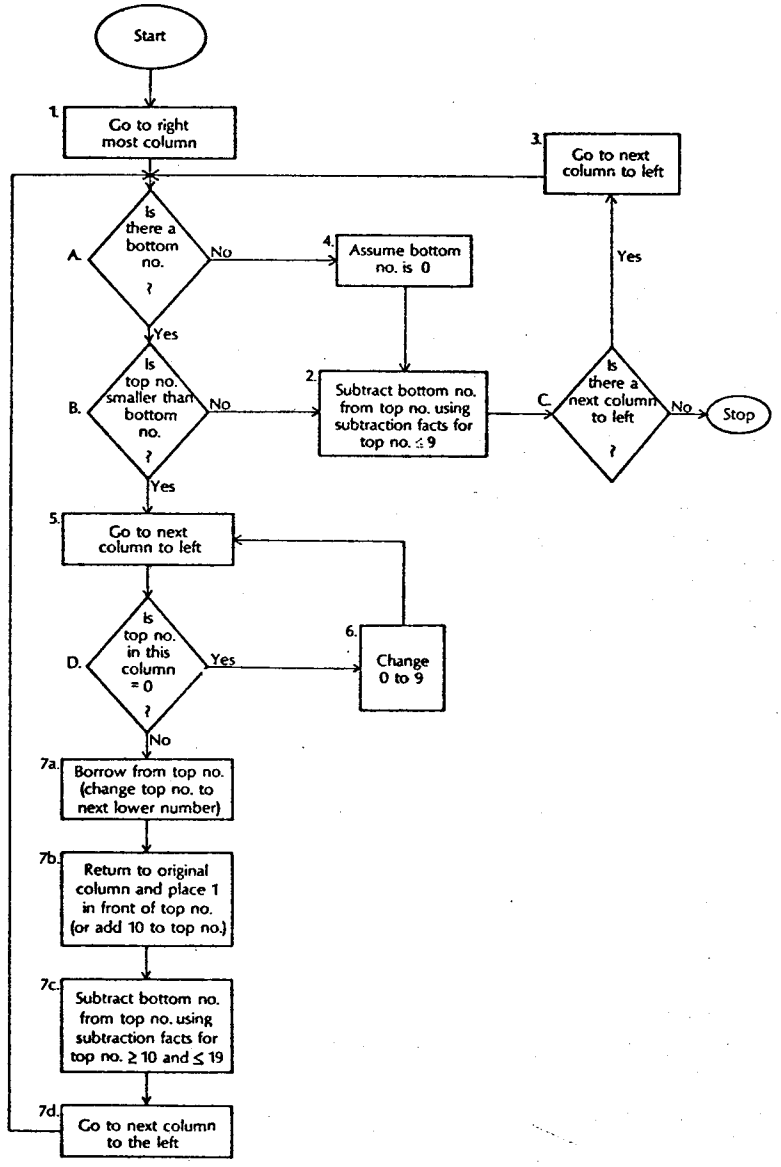


Figure 2: The result of an information processing task analysis (step 1)—a task description for "subtracting whole numbers." (From P. Merrill, 1978, p. 36, with permission.)

Practice

(Space does not permit including practice with feedback.)

Step 2. Decide Which Operation to Teach First

Generality

Look for *simplifying assumptions* which serve to "lay bare" the fundamental procedure. In the performance of any task, there are some operations which can be eliminated without altering the fundamental procedure. Operations can be eliminated by:

1. eliminating complex *alternatives* and
2. eliminating some *component operations.*

Path analysis (see P. Merrill, 1978) can be very helpful for doing this step.

The result of this step is the identification of the most fundamental procedure—the procedure that best *epitomizes* the whole set of operations. Hence this fundamental procedure is called the "epitome" (ē·pit'ō·mē), and it will be the first thing taught to the student.

Example

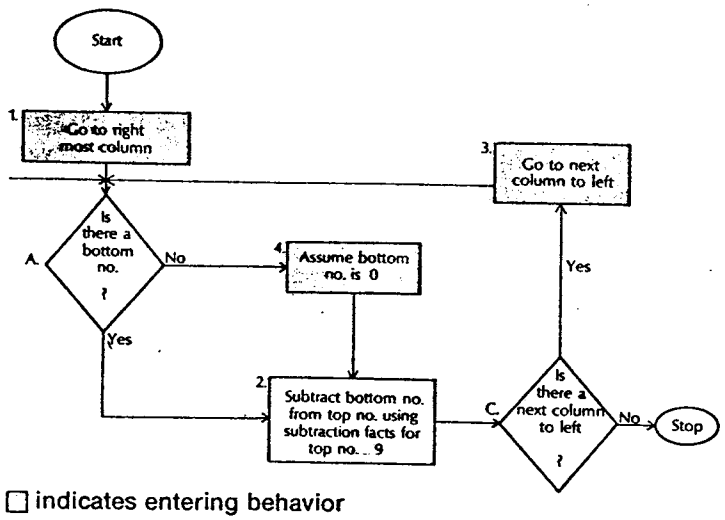
Using the subtraction example in Figure 2, we may assume that a *complex alternative* has already been eliminated. The instruction might have included subtraction of fractions in addition to whole numbers, but we have eliminated those operations which would be required to perform the fraction alternative.

Elimination of *component operations* serves to exclude those operations which are not always essential to performance of the fundamental procedure. A learner can subtract some whole numbers without even knowing what to do if borrowing from a zero is necessary (e.g., 103–27) or even just if borrowing from a non-zero number is necessary (e.g., 65–47). The elimination of these occasionally nonessential operations results in identifying the epitome—the content for the first piece of instruction. Note that three of the operations are entering knowledge; hence operation 2, "Subtract bottom

in Figure 3

Lesson	Operations in Lesson	Type of Instances in Lesson
1. Epitome	①, 2, ③, ④	147 – 24

◯ indicates entering behavior



☐ indicates entering behavior

Figure 3.

number from top number . . . " is all that needs to be taught in the epitome. It would be possible to further simplify the epitome by eliminating operation 4 (assumption: there is always a bottom number) or even operations 3 and 1 (assumption: only one column), but considering that those operations are entering knowledge, there is no need to further simplify.

Step 3. Sequence All the Remaining Operations

Generality

To sequence the remaining operations listed in the task description you gradually relax the simplifying assumptions, and thus gradually add in instruction on the previously eliminated operations. The first assumption to be relaxed should be the one that requires the next most fundamental operation to be taught. (To operationalize "fundamental," think in terms of usefulness and representativeness of the terminal procedure.)

The result of this step is the allocation of all operations in the task description to different "levels of elaboration." The most fundamental operation after the one included in the epitome comprises the first level of elaboration, the next most fundamental operation comprises the second level of elaboration, and so on.

Example

Once learners are able to subtract under the simplifying assumptions included in the epitome, the next most fundamental operation to learn is borrowing. However, at this point (the level 1 elaboration) we should make the simplifying assumption that learners will not have to borrow from a zero. The content which results is shown in Figure 4.

The last operation in the task description can now be taught in the second level of elaboration: borrowing from zero (step 6). See Fig. 5.

The result of steps 1, 2, and 3 of the ET design procedure is the "blueprint" shown in Figure 6.

Step 4. Create All Expanded Epitomes

Generality

An expanded epitome is the epitome plus all operations taught since the epitome. It comes at the end of each level of elaboration (although not after the epitome) and provides a systematic opportunity to review and synthesize. To form the expanded epitome for the level 1 elaboration, describe the task that includes the operations taught in the epitome and in level 1. To form the expanded epitome for the level 2 elaboration, describe the task that includes the level 1 expanded epitome plus the level 2 operation. And so on.

Example

The expanded epitome following the level 1 elaboration synthesizes the content taught in the epitome (subtraction without borrowing) and in level 1 (borrowing when the number borrowed from is not zero). Hence the level 1 expanded epitome contains operations 1, 2, 3, 4 from the epitome and 5, 7, from level 1—it integrates the yes and no paths from decision box B in the task descriptions (see Fig. 7 below). In a similar manner, the level 2 expanded epitome contains operations 1, 2, 3, 4, 5, 7 from the level 1 expanded epitome and 6 from level 2—it integrates the yes and no paths from decision box D in the task descriptions (see Fig. 7 below).

Step 5. Design Instruction on Each Operation and Expanded Epitome

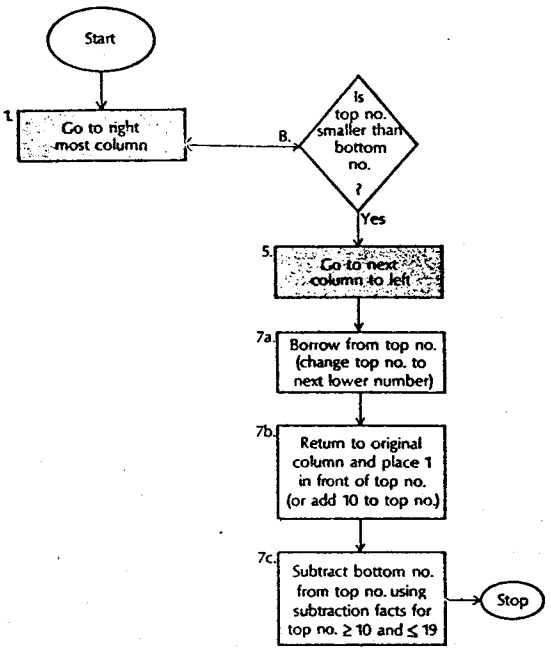
Generality

We now know the sequence in which the various pieces of content will be taught; the "macro" design questions have been answered: selection, sequencing, synthesizing, and summarizing. However, having committed ourselves to designing good instruction, it would be foolish to believe that good macro strategies alone will provide the most effective instruction. Equally important is how we design the instruction that actually *teaches* each operation—how we select "micro" strategies.

Lesson	Operations in Lesson	Type of Instances in Lesson
2. First level of elaboration	(1), (5), 7	13 - 5

◯ indicates entering behavior

Level–1 Elaboration:



□ indicates entering behavior

Figure 4.

This step requires the utilization of M. D. Merrill's Component Display Theory (M. D. Merrill, 1979; M. D. Merrill, Reigeluth, & Faust, 1979; M.D. Merrill, Richards, Schmidt, & Wood, 1977). Since we want students to be able to apply the operations to many instances, we should use a generality, some examples, and some practice. The *generality* is a statement of the operation that makes no reference to any specific application (instance) of the operation. An *example* is a specific application of the operation in which the student is shown how it is done in that one instance. *Practice* offers learners the opportunity to solve a problem and then to find out how they did on it. It is identical to an example except that the student is not shown how it is done until after he/she has tried to do it.

You should make sure that the examples and practice items are as *different* from each other in as many ways as the student is likely to encounter in the real world, that they are arranged in a *progression of difficulty* from easy to difficult (which may include variation in response mode as well as manipulation of variable attributes), and are clearly *labeled* as examples or practice.

Some operations are more difficult for students to learn than others. If you expect an operation to be fairly difficult for the students, you should include a larger number of examples and practice items. You might also consider some additional techniques that can make the learning easier such as *alternative representations* (e.g., a flow chart or other kind of diagram), and *attention-focusing devices* (e.g., underlining or color highlighting important points). For more information about what these micro strategies are like and when they should be used in the design of instruction, see the papers by M. D. Merrill referenced two paragraphs earlier.

All of the above should be done for each expanded epitome as well as for every operation.

While it is important to analyze both content and tasks, analysis itself is not enough; and the analysis we do should be directed specifically at information needed to design the instruction.

Examples

Due to space limitations, we must refer you to M. D. Merrill, Richards, Schmidt, & Wood (1977) for examples of micro strategies and their appropriate use.

Synthesizer

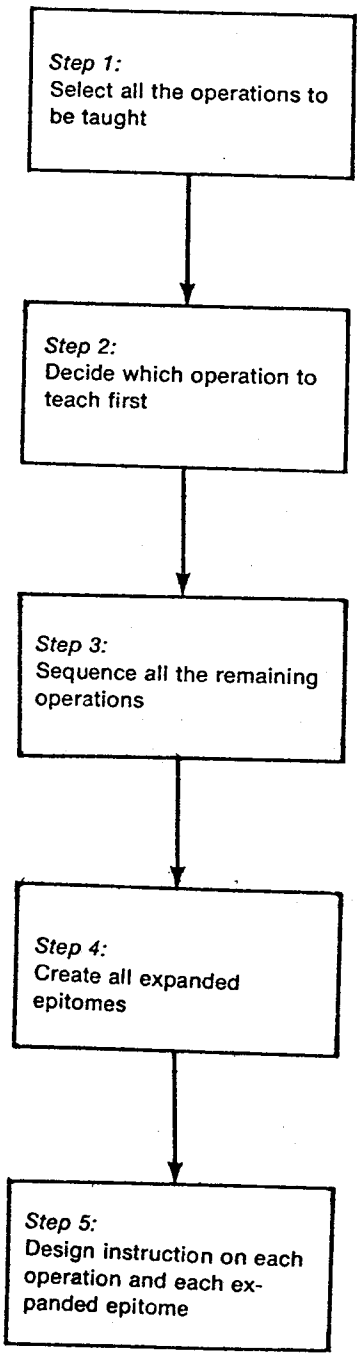
In this lesson we have seen that there are five major steps to designing instruction according to the Elaboration Theory (see Fig. 8)

Example

Figure 9 shows the integrated blueprint which results from applying the epitome procedure to the subtraction of whole numbers. (Note the micro blueprint from step 5 is missing but would have been included here also if space permitted.)

Lesson	Operations in Expanded Epitome	Types of Instances in Expanded Epitome
1. Epitome		
2. First level of elaboration	1, 2, 3, 4, 5, 7	23 − 5 / 2257 − 69
3. Second level of elaboration	1, 2, 3, 4, 5, 6, 7	203 − 95 / 2057 − 69

Figure 7.



Conduct an information processing task analysis.

Use path analysis and simplifying assumptions to identify the most fundamental operation—the epitome.

Relax the assumptions according to which operation is the next most fundamental one—this is the level 1 elaboration. Continue this process until all operations have been allocated.

For the level 1 elaboration, describe the task that includes the operations in the epitome and level 1. For the level 2 elaboration, describe the task that includes the operations in the level 1 expanded epitome and level 2. Continue this process until all content is integrated.

Prescribe micro strategies for each operation and for each expanded epitome: a generality, some examples, and some practice. Prescribe ways in which examples and practice should vary, how progression of difficulty should be accomplished, and how they should be formatted. Also prescribe richness of strategy: number of examples and practice items and presence or absence of alternative representations and attention-focusing devices.

Figure 8.

tive for learning the operation in that lesson. All supporting content that meets this criterion should be included in the same level as its corresponding operation.

Step 4 should be expanded to read: "Sequence all the instruction within each lesson," which includes both the organizing content (the operation) and the supporting content (principles, concepts, and/or learning prerequisites). The new generalities for this step would describe how to sequence that content, including the sequencing of learning prerequisites, supporting principles, and conceptual relationships—in relation to when the operation itself is taught. An additional generality would describe how to make a summarizer, which is a concise generality for each operation, concept, and principle that was taught in this lesson; and it would explain that it should come at the end of the lesson but just before the expanded epitome. Our previous step 4, "Create all expanded epitomes," becomes the last part of this step.

The expanded epitome for this level of elaboration would include Figure 10 below as well as some integrated examples and practice.

Level 2 Elaboration

Another simplifying assumption we made to form the epitome of the design procedure is that there is only one new operation on each level of elaboration. This assumption only holds for very short courses (i.e., for very small tasks) and even then it does not always hold. Usually the size of the course requires that more than one operation be included at each level of elaboration. In such situations an additional step is added that allows us to decide how to sequence the different lessons (one for each operation) within each level.

The new step is as follows: "Allocate all content within each level to individual lessons and decide how to sequence those lessons." This step comes between steps 4 and 5 in our level 1 expanded epitome (Fig. 10). The lesson on the level 2 elaboration would contain the following generalities. First, each operation within a level is allocated to a different les-

Lesson	Operations in Lesson	Type of Instances in Lesson	Operations in Expanded Epitome	Type of Instances in Expanded Epitome
1. Epitome	1, 2, 3, 4	147 − 24		
2. First level	1, 5, 7	13 − 5	1, 2, 3, 4, 5, 7	23 2257 − 5 − 69
3. Second level	1, 5, 6, 7	103 − 95	1, 2, 3, 4, 5, 6, 7	203 2057 − 95 − 69

Figure 9.

son, and all supporting content is placed in the same lesson as its corresponding operation. Second, another generality would describe how to sequence the lessons which were just formed. Sequencing could be predetermined (i.e., fixed) or it could be variable (i.e., flexible). If it is variable, it could be learner-controlled or system-controlled. If it is predetermined, the sequence of lessons would be based primarily on which operations are most fundamental (as explained earlier). Design procedures would be described for each of these alternatives.

The expanded epitome for this level of elaboration would include Figure 11 below as well as some integrated examples and practice.

Level 3 Elaboration

A third simplifying assumption made was that no lesson would include instruction on more than one operation. This may sound like the assumption described at level 2, but that assumption referred to the number of *lessons* at each level of elaboration. This assumption involves the number of operations that we would include *within* a lesson, as determined by the optimal size of the lesson. (This is a less fundamental assumption and is, therefore, relegated to the third level of elaboration.) Relaxing this assumption requires modifying two existing steps: steps 5 and 6 of the level 2 expanded epitome (see Figure 11).

With respect to modifying step 5, "Allocate all content to lessons and sequence them," you should not *always* allocate each operation to a different lesson. One generality would explain that since there is review and synthesis at the end of each lesson, each lesson should be neither too large nor too small (neither too many nor too few operations in this case). If it is too large, achievement and motivation will suffer and there will be too much content to be effectively synthesized in the expanded epitome. If it is too small, the review and synthesis will reduce the efficiency of the instruction and demotivate the learner. The amount of content in the lesson should represent an "optimal learning load," which is determined on the basis of the difficulty level of the content in relation to the ability level of the learners. We roughly estimate that it should represent about 45 to 60 minutes of instruction.

Another generality would explain that the amount of content in a lesson can be adjusted to the optimum learning load by adding another operation (plus supporting content) if the load is too light or by splitting some supporting content out into a second lesson if the load is too heavy.

A third generality would describe how to decide which operations should be grouped into a single lesson. They should be grouped on the basis of relatedness—the more closely related operations being grouped together. If alternatives for grouping are about equally related, then size may be important for making grouping decisions.

The sequencing of lessons in step 5 is not changed.

With respect to modifying step 6, "Sequencing within each lesson," it will now often be necessary to sequence more than one operation (and all its supporting content) within a lesson. Some generalities in this lesson would describe the basis for deciding how to sequence this increased amount of content. (It is not always best to teach one operation and its supporting content prior to and unmixed with another operation and its supporting content.) Another generality in this lesson would describe how to create an introduction to the organizing content (the operations) in a lesson. Such an introduction will often make use of a "familiarizer" (Stein, Witham, & Reigeluth),[1] which relates what is about to be learned to something (outside of the content for this lesson) that the student already knows.

The identification of content for the summarizer and the expanded epitome that follow each lesson remains unchanged.

The expanded epitome for this level of elaboration would include Figure 12 below as well as some integrated examples and practice.

Level 4 Elaboration

The only remaining simplifying assumption that we made is that a procedural organization is the only one we would use. Very often, however, a theoretical or conceptual organization is more appropriate for the goals of a course and will result in more effective and efficient instruction for achieving the course goals. This level of elaboration would provide an epitome of the design procedure for theoretical or-

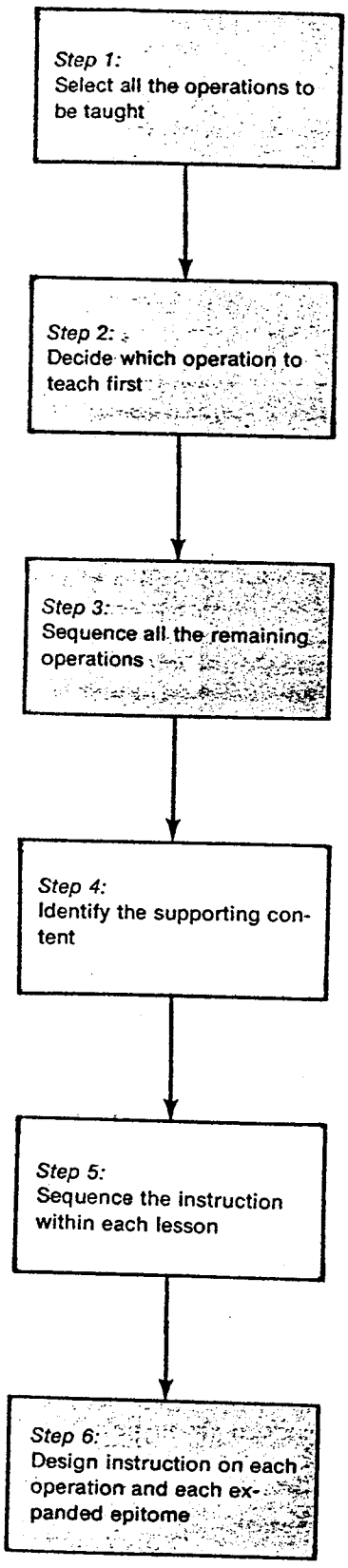


Figure 10.

ganizations and an epitome for conceptual organizations. The fundamentals of the designs are the same for all three organizations, but the procedures for implementing those fundamental principles are quite different. For a general idea of what those designs are like, see Reigeluth (1979) and Reigeluth, M. D. Merrill, Wilson, & Spiller (in press). Also, we are currently working on a book that will provide full-blown instruction on all four levels of elaboration described here (in addition to the epitome) and on the subsequent elaborations on the theoretical and conceptual epitomes comprising level 4.

Conclusion

Elaboration Theory offers the designer of instruction prescriptions for sequencing and synthesizing content. While it is important to analyze both content and tasks, analysis itself is not enough; and the analysis we do should be directed specifically at information needed to design the instruction (i.e., to select the best strategies). We need to have theoretically-based analysis and design procedures. Elaboration Theory is a synthesis of many principles and theories of learning and instruction. In prescribing designs for the three different kinds of organizations—conceptual, theoretical, and procedural—E.T. incorporates the ideas of assimilation and subsumption, hierarchical learning, and information processing, as well as principles of motivation. As such, E.T. provides a comprehensive theory of instructional design which enhances our ability to design good instruction.

Reference

[1]Stein, F. S., Witham, J. K.,& Reigeluth, C. M., Relating what is to be learned to what is known: Subsumptive sequencing, familiarizers, and generic skills activation. *IDD&E Working Papers*, No. 2, in press.

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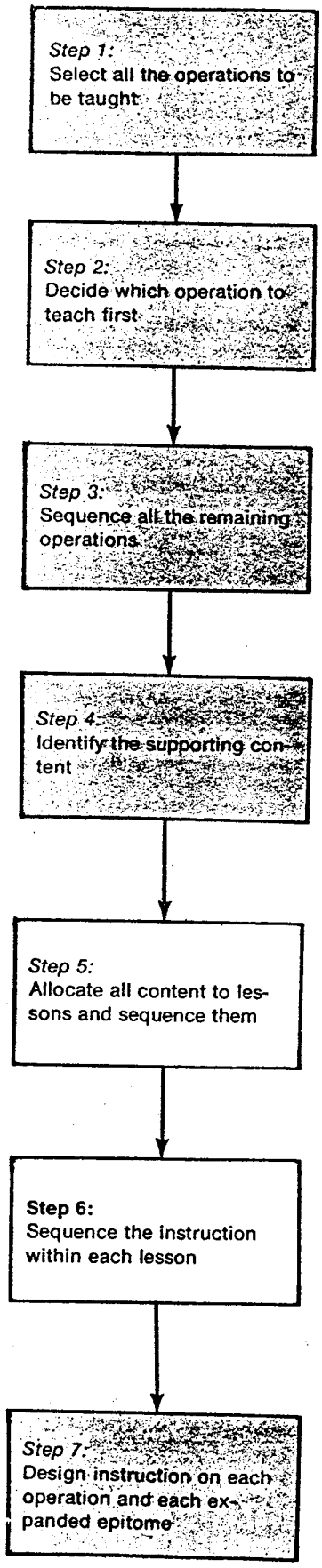

Conduct an information processing task analysis.

Use path analysis and simplifying assumptions to identify the most fundamental operations—the epitome.

Relax the assumptions according to which operation is the next most fundamental one—this is the level 1 elaboration. Continue this process until all operations have been allocated.

Identify principles, conceptual relationships, and learning prerequisites that are highly supportive for learning each operation. Include this supporting content in the same level as its corresponding operation.

Allocate operations and supporting content on each level to lessons according to their degree of relatedness and in such a way as to create an "optimal learning load."

Decide on the sequencing of supporting principles, conceptual relations, and learning prerequisites in relation to when all operations are taught. Also, create an introduction to the organizing content for each lesson, which often involves using a "familiarizer." Finally, identify the content for the summarizer and for the expanded epitome that follow each lesson.

Prescribe micro strategies for each operation and for each expanded epitome: a generality, some examples, and some practice. Prescribe ways in which examples and practice should vary, how progression of difficulty should be accomplished, and how they should be formatted. Also, prescribe richness of strategy: number of examples and practice items and presence or absence of alternative representations and attention-focusing devices.

Figure 12.