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Elaboration Theory of Instruction

The elaboration theory of instruction offers a holistic approach to sequencing instruction that helps make learning more meaningful and is more motivating for learners (Reigeluth 1999b; abstracted here with permission of the publisher). It also can allow learners to have more control over some scope and sequence decisions during the learning process. This stands in sharp contrast to the parts-to-whole sequencing, superficial coverage of content, and teacher control over scope and sequence decisions that have been typical of education and training since 1900. (The term "content" is used here to refer to everything that comes under "what to teach." It therefore includes whatever tasks you might teach, as well as whatever knowledge; the term "content analysis" includes "task analysis.")

The elaboration theory recognizes that different kinds of sequences are needed for different instructional situations. Thus it synthesizes recent work on scope and sequence into a single coherent framework, extending that work where holes were found. It currently deals only with the cognitive and psychomotor domains and not the affective domain. (However, there are strong indications that it can be, and indeed is already intuitively being, applied in the affective domain; see, e.g., Greenberg and Kusché 1993; Goleman 1995.)

To understand the elaboration theory, it is helpful to begin with some general issues about the form of the elaboration theory and the nature of instructional sequencing. Then the kinds of situations that call for different kinds of elaboration sequences are discussed. Finally, the three major kinds of sequences offered by the elaboration theory are described.

General Issues about Elaboration Sequencing

One general issue is that elaboration theory is a design theory rather than a descriptive theory (Simon 1969); this means that it is oriented toward achieving goals and making decisions rather than making descriptions and conclusions (Cronbach and Suppes 1969). Its purpose is to offer guidance on the best means for accomplishing a given goal, where "best" is determined by a set of criteria appropriate to the situation at hand. Therefore, the major parts of elaboration theory are (1) methods and (2) the situations under which each method is likely to be best.

Also, elaboration theory is an instructional theory, which means that its purpose is to offer guidance on what methods of instruction are likely to be best for different situations. The elaboration theory deals only with macro-level (broad) methods: guidance for making scope and sequence decisions—decisions about what to teach and what order to teach it.

Sequencing is Based on Relationships

The second general issue is that each method of sequencing is based upon a single type of relationship among parts of the content. For instance, a historical sequence is based upon the chronological relationship—the actual sequence of events. A procedural sequence, the most common kind of sequencing in training, is based upon the relationship of "order of performance" of the steps in the procedure. A hierarchical sequence is based upon the relationship of learning prerequisites among the various skills and subskills that comprise a task. And the "simplifying conditions" sequence (described later) is based upon the relationship of the degree of complexity of different versions of a complex task.

Topical and Spiral Sequencing

A third general issue is that two basic patterns of sequencing can be used that are fundamentally different: topical and spiral (see Figure 1). In topical sequencing, a topic (or task) is taught to whatever depth of understanding (or competence) is desired before moving to the next one. In spiral sequencing (Bruner 1960), the learners master a topic (or task) gradually in several passes. They learn the basics of one topic (or task), then another, and another, and so on, before they return to learn more about each topic. This pattern continues until the desired depth and breadth are reached for all of them.

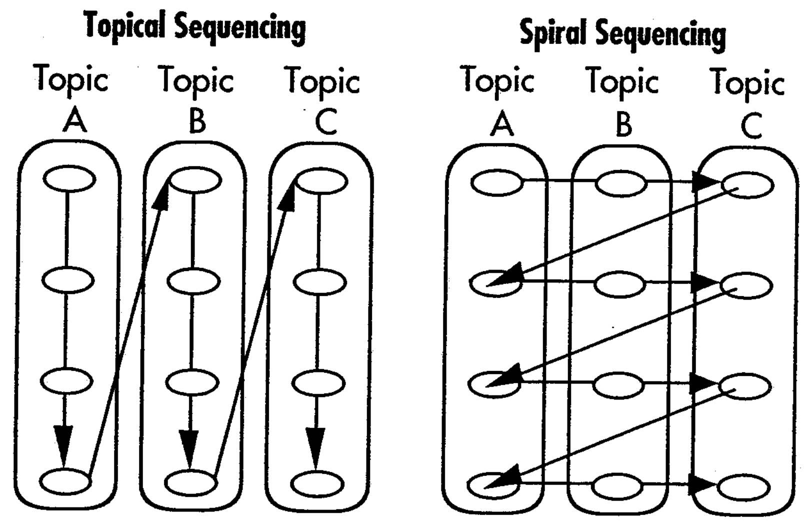


FIGURE 1: Topical and Spiral Sequencing

SOURCE: Created by the author.

Rather than thinking of spiral and topical sequencing as two separate categories, it is useful to think of them as the two endpoints along a continuum. The instructional designer's (or the learner's) decision, then, is where on the continuum to be for any given training program or curriculum and for any given group or individual learner—or when to be at any given point on the continuum.

Different Sequences for Domain Expertise and Task Expertise

The elaboration theory is founded on the notion that different sequences are best for different situations, because different sequencing methods are based on different kinds of relationships within the content, and different relationships are important for different kinds of expertise. So the kind of sequence that will most facilitate learning depends on the kind of expertise one wants to develop.

Elaboration theory distinguishes between task expertise and subject-domain expertise (Reigeluth 1999a). With task expertise the learner becomes an expert in a task, such as managing a project, selling a product, or writing an annual plan. With domain expertise the learner becomes an expert in a subject area not tied to any specific task, such as economics, electronics, or physics (but often relevant to many tasks). This is different from the distinction between procedural and declarative knowledge (J. R. Anderson 1983).

Task Expertise

Tasks range from simple to complex. The elaboration theory is intended only for more complex tasks. It is based on the observation that complex cognitive and psychomotor tasks are done differently under different conditions, that each set of conditions defines a different version of the task, and that some of those versions are much more complex than others. Thus, the elaboration theory offers the simplifying conditions method (SCM) to design a holistic, simple-to-complex sequence by starting with the simplest real-world version of the task and gradually progressing to ever-more complex versions as each is mastered. Problems or projects that learners tackle should be ones that are within the so-called zone of proximal development (Vygotsky 1978)—close enough to the learner's present competence for the learner to be able to deal with successfully—and the problems or projects should gradually increase in complexity.

Domain Expertise

Domain expertise ranges from simple to complex, but also from general to detailed. The general-to-detailed nature of domain expertise allows the design of a holistic sequence that goes from simple to complex. (The elaboration theory's sequencing guidance for domain expertise was derived primarily from Bruner's 1960 spiral curriculum and Ausubel's 1968 advance organizers and progressive differentiation. But it differs in several important ways from each, and it also provides greater guidance on how to design such a sequence.) An elaboration sequence starts with the broadest, most inclusive, most general ideas (which are also the simplest and generally among the first to have been discovered). Examples include the law of supply and demand in economics and Ohm's law in electricity. The sequence gradually progresses to more complex, precise ideas. Examples include ideas related to maximizing profits on the supply side (marginal revenues and marginal costs) and to consumer preferences on the demand side. This makes an elaboration sequence ideal for discovery learning, inquiry learning, and other approaches to the construction of knowledge.

The elaboration theory recognizes two major kinds of domain expertise: conceptual (understanding what) and theoretical (understanding why). In their simplest forms, these are concepts and principles, respectively. In their more complex forms, they are *conceptual knowledge structures* (or concept maps) for "understanding what," and both causal models and *theoretical knowledge structures* for "understanding why."

The conceptual elaboration sequence is briefly described next, followed by the theoretical elaboration sequence, and finally the SCM sequence.

The Conceptual Elaboration Sequence

The conceptual elaboration sequence (Reigeluth and Darwazeh 1982) is based on several observations. The first is that concepts are groupings or classes of objects, events, or ideas that share certain characteristics. For example, "tree" is a concept that includes all individual plants that have certain characteristics, most notably a woody stem. The second observation is that concepts can be broken down into either parts or kind, which are narrower, less inclusive concepts. For example, parts of trees include the trunk, roots, branches, and leaves. Kinds of trees include deciduous and evergreen. And each of those parts and kinds can be further broken down into parts and kinds. The third observation is that people tend to store a new concept under a broader, more inclusive concept in their heads (cognitive structures). The broader concept provides "cognitive scaffolding" (Ausubel 1968). The process of learning that proceeds from broader, more inclusive, and general concepts to narrower, more detailed concepts was called "progressive differentiation" (Ausubel 1968) because it entails a process of making progressively finer distinctions.

The kind of relationship upon which the conceptual elaboration sequence is based is that of parts or kinds of concepts (called the relationship). Such relationships include superordinate, coordinate, and subordinate relationships. In Figure 2, classical music is subordinate to music, is coordinate to medieval music, and is superordinate to instrumental classical music. As you go farther down in the conceptual structure to kinds of kinds of kinds (or parts of parts of parts), the concepts become ever narrower and more detailed. David Ausubel (1968) proposed that new concepts are organized in our heads under more inclusive concepts. Thus if one learns a broader, more inclusive concept before its subordinate concepts, the cognitive structure is more likely to be a sound one that will not have to be reorganized to accommodate new learning.

The conceptual elaboration sequence is one that starts by teaching (or discovering) the broadest, most inclusive, and general concepts that the learner has not yet learned and proceeds to ever more narrow, less inclusive, and more detailed concepts until the desired level of detail has been reached. This kind of sequence might be used by a high school student interested in learning about the kinds and parts of animals and plants or by an employee interested in learning about the kinds and parts of equipment that the company sells.

How do you identify all these concepts and their inclusivity relationships? This is the purpose of a conceptual analysis. The result of such an analysis is a conceptual knowledge structure (see Figure 2), sometimes called a taxonomy. The term "hierarchy" is sometimes used, but that term usually refers to a learning hierarchy (Gagné 1968).

The conceptual elaboration sequence may be designed in either a topical or spiral manner. For a topical sequence, one could go all the way down one leg of the conceptual structure and gradually move on to other topics, one leg at a time. For a spiral sequence, one could go completely across the top row, then across the next row down, and so forth.

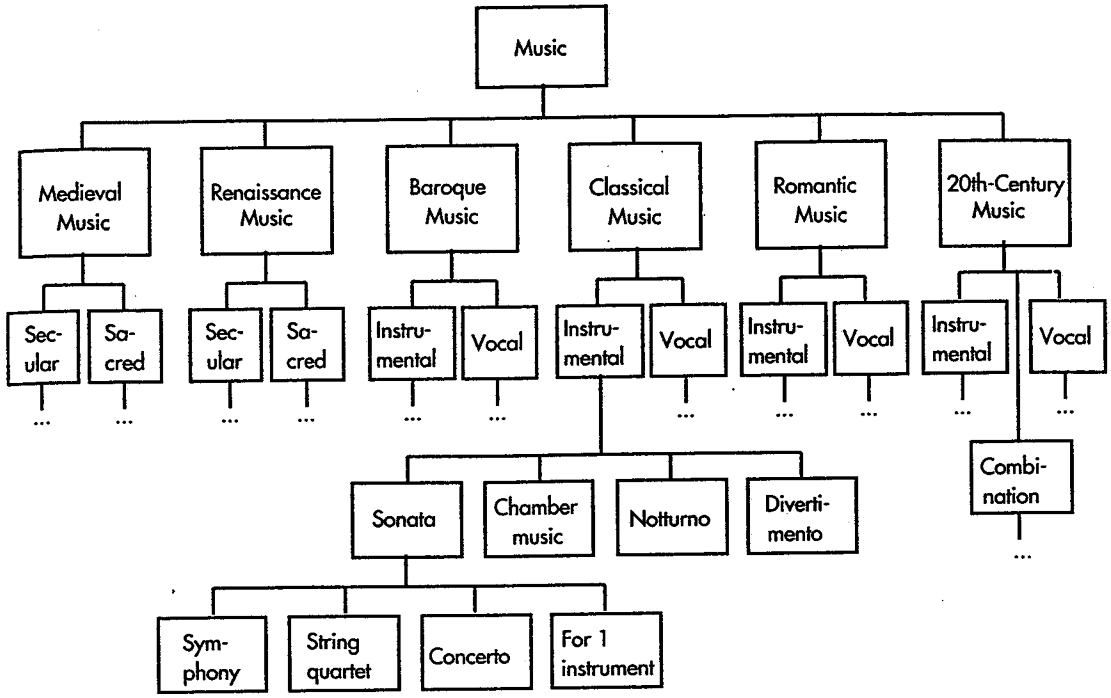


FIGURE 2: An Example of a Conceptual Structure

SOURCE: Reprinted from Charles M. Reigeluth, ed. (1999), *Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory* (Mahwah, NJ: Lawrence Erlbaum Associates).

The Theoretical Elaboration Sequence

The theoretical elaboration sequence is the second of the two sequencing methods currently offered by the elaboration theory for building domain expertise. It is intended for courses that focus on interrelated sets of principles, which are usually elaborations of each other, such as a high school biology course that focuses on principles of genetics, life cycles, and bodily functions, or a corporate training program on how and why a piece of equipment works.

This sequencing method is based on several observations. The first is that principles are either causal relationships or natural-process relationships (both of which concern changes in concepts). For example, the law of supply and demand says how changes in the supply of, and demand for, something influence its price, and vice versa (how changes in its price influence its supply and demand).

The second observation is that principles, like concepts, exist on a continuum from broader, more general, and more inclusive ones to narrower, more specific, and less inclusive ones. For example, a fairly general principle is: Temperature change in an environment causes behavioral changes in certain organisms within that environment. And two subordinate principles are: High temperatures in a desert environment cause certain organisms to be nocturnal; and high temperatures in a desert environment cause certain organisms to undergo a period of estivation (a summertime equivalent of hibernation). This last principle could be further elaborated by identifying specific physiological changes that occur in a particular species when it estivates. Figure 3 shows another example. So, unlike concepts, the broader principles are generally simpler and easier to learn than the narrower ones. This quality led principles to be the focus of the spiral curriculum (Bruner 1960).

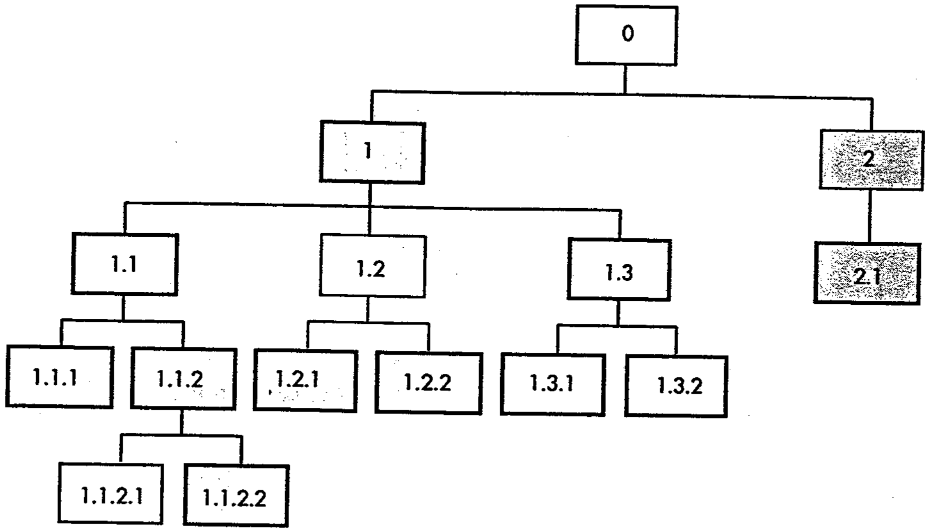
The third observation is that people tend to store a new principle under a broader, more inclusive one in their cognitive structures as they do for a new concept. Again, Ausubel (1968) discovered that the broader principle provides "cognitive scaffolding" for the narrower, more complex principles and therefore recommended the general-to-detailed sequencing method he called "progressive differentiation."

But there is a fourth observation for principles that does not hold for concepts. Principles can be combined into causal models that reflect the complex, systemic, and often seemingly chaotic nature of most phenomena in the world. A causal model is a set of interrelated cause-effect relationships, in which there are chains of causes and effects, and there are usually multiple causes of the effects and multiple effects of the causes (see Figure 4). These causal relationships are usually probabilistic rather than deterministic, meaning that the cause will increase the chances of the effect occurring rather than making it happen.

Figure 4 shows part of a complex causal model related to the water cycle. Each box shows a change—either an increase (shown by a rising arrow) or a decrease (shown by a declining arrow) in some activity or condition. The arrows between boxes show the direction of causality. So looking at the top of the diagram, one would read, "An increase in surface temperature causes (or more accurately increases the chances of) an increase in evaporation."

The theoretical elaboration sequence starts by teaching the broadest, most inclusive, most general principles that the learner has not yet learned in a theoretical structure (which are also the simplest principles and generally the first to have been discovered); and it gradually progresses to ever more narrow, less inclusive, more detailed, more precise principles (which are also more complex and were generally discovered later). Examples for economics (the law of supply and demand) and electricity (Ohm's law) are relevant. This sequence continues until the desired level of complexity has been reached. The fact that this order reflects the order in which the principles were usually discovered, and could be most easily discovered by learners, makes this sequence ideal for inquiry learning and other discovery methods.

When light rays pass from one medium into another (of different optical density):



0 they behave unexpectedly,
1 they bend at the surface,
2 a straight object in both media looks bent at the surface,
1.1 the rays bend because they slow down in a denser medium or speed up in a less dense medium (C),
1.2 rays bend and change their distance from each other but remain parallel to each other (A),
1.3 a portion of each ray is reflected off the surface, while the rest is refracted into the new medium (A),
2.1 the apparent position and size of an object usually change (A),
1.1.1 if they pass into a denser medium, the light rays bend toward the normal (B, D),
1.1.2 the greater the difference in optical density between two media, the more the light rays bend (D),
1.2.1 when rays bend toward the normal, they become farther apart (B, D),
1.2.2 the sharper the angle between a light ray and the surface, the more the ray bends (D),
1.3.1 the sharper the angle between a light ray and the surface, the more of each ray that is reflected and the less that is refracted (D),
1.3.2 if the angle is equal to, or sharper than, the critical angle, all of the light ray is reflected (B, E),
1.1.2.1 the index of refraction (n) = c_i/c_r = (sin i)/(sin r) (D, E),
1.1.2.2 the relationship between the critical angle and the index of refraction is: $\sin i_c = 1/n$ (D, E).

Codes:
(A) What else happens? (B) When? (B) Why? (C) Which way? (D) How much?

FIGURE 3: An Example of a Theoretical Structure

SOURCE: Reprinted from Charles M. Reigeluth, ed. (1999), *Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory* (Mahwah, NJ: Lawrence Erlbaum Associates).

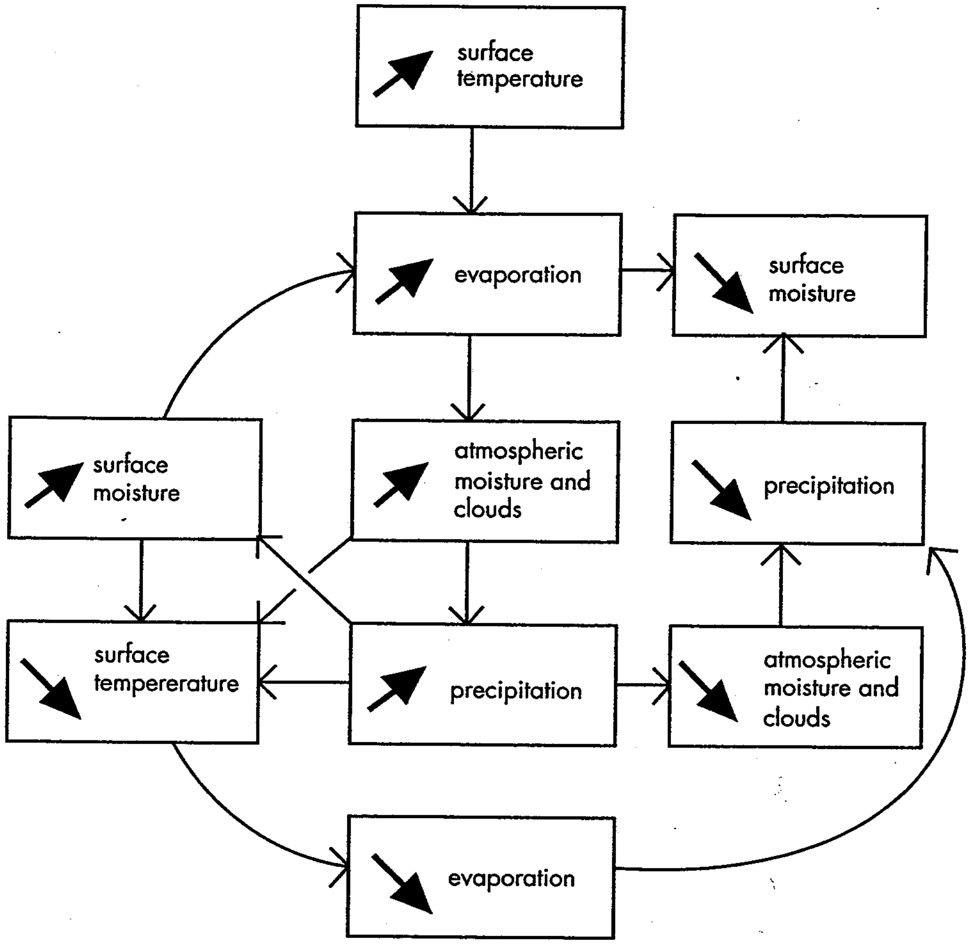


FIGURE 4: A Partial Example of a Causal Model Related to the Water Cycle

SOURCE: Reprinted from Charles M. Reigeluth, ed. (1999), *Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory* (Mahwah, NJ: Lawrence Erlbaum Associates).

How does a teacher or designer identify all these principles and their inclusivity/complexity relationships? This is the purpose of a theoretical analysis. The result of such an analysis is a theoretical structure (see Figure 3), which is different from a causal model (see Figure 4) in that it shows principles that elaborate on other principles (that provide more complexity or guidance on the same phenomena), whereas a causal model shows principles that combine with other principles (add new phenomena), usually at a similar level of complexity. In Figure 3, principles 1 and 2 elaborate on principle 0 because they each provide more complex information about what happens when light rays pass from one optical medium into another of different optical density.

It should be noted that more detail can be provided by elaborating on either the causal factors or the resultant factors (effects) or both. And elaboration can occur by answering several different kinds of questions, such as:

- What else happens? or What else can cause this?
- When does this cause have this effect?
- Which way (direction) do things change?
- Why do they change?
- How much do they change?

The theoretical elaboration sequence may also be done in either a topical or spiral manner. For a topical sequence, one could go all the way down one leg of the theoretical structure, then gradually broaden out from there. For a spiral sequence, one could go completely across the top row, then across the next row down, and so forth.

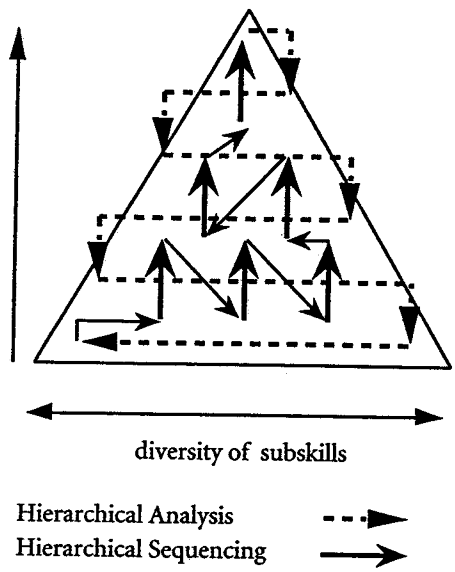
The Simplifying Conditions Method

For building task expertise, SCM is a relatively new approach (though practitioners have long used it intuitively) that offers guidance for analyzing, selecting, and sequencing the "what to learn" (content). Briefly, SCM provides practical guidelines to make a very different kind of simple-to-complex sequence from the parts-to-whole (hierarchical) sequence—one that is holistic rather than fragmented. Any complex task has some conditions under which it is much easier to perform than others. For example, driving a car is easier when you have an automatic shift, no traffic, good weather, no need to start on a hill, and no need to parallel park. An SCM sequence begins with mastery of the simplest version of the task that is still fairly representative of the task as a whole; then it teaches ever more complex versions of the task until the desired level of complexity is reached, making sure that the learner is aware of the relationship of each version to the other versions. Each version of the task is a class or group of complete, real-world performances of the task. This process contrasts sharply with the hierarchical approach to sequencing, which teaches all the prerequisites first and does not teach a complete, real-world task until the end of the sequence. Figure 5 shows the differences between the hierarchical approach and the SCM approach. Note that as you conduct a hierarchical task analysis, the subskills become ever more varied (diverse) yet steadily simpler. In contrast, when you conduct a simplifying conditions analysis, the subtasks become ever more varied yet steadily more complex.

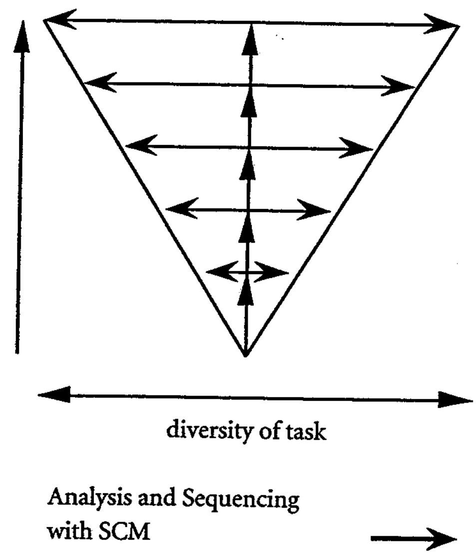
For procedural tasks, the focus is on the steps (mental and/or physical) that experts use to decide what to do when. The SCM's selection (scope) and sequencing methodology were derived primarily from the work on "path analysis" of a procedure (Scandura 1973; Merrill 1976, 1980). Every

Conceptual Map

Hierarchical Task Analysis and Sequencing



Task Analysis and Sequencing with SCM



	Hierarchical Task Analysis and Sequencing	Task Analysis and Sequencing with SCM
Underlying Logic	Part to whole/simple to complex (Subskills to main skills)	Simple to complex (simple task to complex task).
For Designer	Task analysis should be done prior to sequencing as separate task.	Task analysis and sequencing can be done simultaneously. The prototype can be developed rapidly.
For Learner	Facilitates the learning of higher-order skills.	From the very first lesson, it provides (1) the flavor of the whole task, (2) a simple but applicable skill, and (3) enhanced motivation.

The hierarchical approach is necessary but not sufficient. It also introduces a very fragmentary approach.

FIGURE 5: Hierarchical Approach and the SCM Approach

SOURCE: Created by the author.

decision step in a complex procedure signals at least two different paths through the flowchart of the procedure (one of which is almost always simpler than the other). It also represents at least two different conditions of performance.

In contrast, for heuristic tasks (Reigeluth 1992; Reigeluth and Kim 1993) the focus is on principles, guidelines, and/or causal models that experts use to decide what to do when (rather than using a set of steps). Such heuristic tasks differ greatly in the nature of an expert's performance, depending on the conditions of performance. Thus, experts do not think in terms of steps when they perform the task. This sequencing methodology was derived by Reigeluth primarily from the procedural SCM sequence.

Both types of SCM sequences are used simultaneously when the task is a combination of both types of knowledge (procedural and heuristic). And the SCM and domain-elaboration sequences can be used simultaneously as well. These are referred to as multiple-strand sequences (Beissner and Reigeluth 1994).

The SCM (for both procedural and heuristic tasks) is composed of two parts: epitomizing and elaborating. Epitomizing involves identifying the simplest version of the task that is still fairly representative of the whole task. Elaborating involves identifying progressively more complex versions of the task.

The principles of epitomizing are based upon the notions of holistic learning and schema-building. Epitomizing utilizes: (1) a whole version of the task rather than a simpler component skill; (2) a simple version of the task; (3) a real-world version of the task (usually); and (4) a fairly representative (typical or common) version of the task. The epitome version of the task is performed by experts only under certain restricted (but usually real-world) conditions, referred to as the simplifying conditions.

The principles of elaborating are similarly based on the notions of holistic learning and assimilation-to-schema. Each subsequent elaboration should be: (1) another whole version of the task; (2) a slightly more complex version of the task; (3) equally authentic (or more so); and (4) equally or slightly less representative (typical or common) of the whole task. The simplifying conditions are removed one by one to define each of the more complex versions of the task.

An SCM sequence is designed by integrating task analysis with design. The analysis/design process centers around the questions, "What is the simplest version of the task that an expert has ever performed?" and "What is the next simplest version?" and so forth. As each version is identified, its place in the sequence is simultaneously determined. (More detailed guidance for analyzing and designing an SCM sequence is provided by Reigeluth 1999a.) Since designing an SCM sequence is more of a heuristic than a procedural process, the guidelines include heuristics as well as steps.

There tend to be more procedural elements at the upper levels of analysis (the major phases of the task). However, there comes a point at which it is no longer productive to break a given step into substeps, for that is not the way an expert thinks. Rather, one must identify the heuristics upon which an expert's performance of the step is based.

The Importance of the Elaboration Theory

The paradigm shift from teacher-centered and content-centered instruction to learner-centered instruction is creating new needs for ways to sequence instruction. In the industrial age paradigm of education and training, the need was to break the content or task down into little pieces and teach those pieces one at a time (Reigeluth 1999b). But most of the new, learner-centered approaches to instruction, including simulations, apprenticeships, goal-based scenarios, problem-based learning, and other kinds of situated learning, require a more holistic approach to sequencing, one that can simplify the content or task, not by breaking it into pieces but by identifying simpler real-world versions of the task or content domain. Elaboration sequences accomplish this and simultaneously make the learning process more meaningful and motivational to learners.

Charles M. Reigeluth

See also Analysis; Bruner, Jerome S.; Gagné, Robert Mills; Instructional Design; Vygotsky, Lev

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An electronic book is the result of combining a digital text with an electronic reading device so that the text can be read in the same manner as a paper-based book. The advent of e-books signals an advance in on-screen reading. Computers and other electronic devices have always supported the reading of text files. However, the text that makes up an e-book is coded to provide many of the features that book lovers and scholars value in printed works. Users "turn" electronic pages by tapping the screen or by pressing a button on a computer or on a hand-held device. Users can also highlight important passages and make annotations or sketches as they read. Other features take advantage of the technology inherent in the computers and