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CHAPTER 3

BIBLIOGRAPHIC INFORMATION

BOOK TITLE: A Taxonomy for Learning, Teaching, and Assessing

Author: L. W. Anderson, D. R. Krathwohl et al. (eds.)

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The Taxonomy Table

As we mentioned in Chapter 1, our framework can be represented in a two-dimensional table that we call the Taxonomy Table (see Table 3.1. For convenient reference, it is also reproduced on the inside front cover). The rows and columns of the table contain carefully delineated and defined categories of knowledge and cognitive processes, respectively. The cells of the table are where the knowledge and cognitive process dimensions intersect. Objectives, either explicitly or implicitly, include both knowledge and cognitive processes that can be classified in the Taxonomy framework. Therefore, objectives can be placed in the cells of the table. It should be possible to place any educational objective that has a cognitive emphasis in one or more cells of the table.

CATEGORIES OF THE KNOWLEDGE DIMENSION

After considering the various designations of knowledge types, especially developments in cognitive psychology that have taken place since the original framework's creation, we settled on four general types of knowledge: *Factual, Conceptual, Procedural,* and *Metacognitive.* Table 3.2 summarizes these four major types of knowledge and their associated subtypes.

Factual knowledge is knowledge of discrete, isolated content elements—"bits of information" (p. 45). It includes knowledge of terminology and knowledge of specific details and elements. In contrast, *Conceptual knowledge* is knowledge of "more complex, organized knowledge forms" (p. 48). It includes knowledge of classifications and categories, principles and generalizations, and theories, models, and structures.

Procedural knowledge is "knowledge of how to do something" (p. 52). It includes knowledge of skills and algorithms, techniques and methods, as well as knowledge of the criteria used to determine and/or justify "when to do what" within specific domains and disciplines. Finally, *Metacognitive knowledge* is "knowledge about cognition in general as well as awareness of and knowledge about one's own cognition" (p. 55). It encompasses strategic knowledge; knowledge about cognitive tasks, including contextual and conditional knowledge; and self-knowledge. Of course, certain aspects of metacognitive knowledge are

3.1 The Taxonomy Table

The Knowledge Dimension	The Cognitive Process Dimension					
	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A. Factual knowledge						
B. Conceptual knowledge						
C. Procedural knowledge						
D. Meta-cognitive knowledge						

3.2 The Major Types and Subtypes of the Knowledge Dimension*

Major Types and Subtypes	Examples
A. Factual knowledge—The basic elements students must know to be acquainted with a discipline or solve problems in it	
Aa. Knowledge of terminology	Technical vocabulary, musical symbols
Ab. Knowledge of specific details and elements	Major natural resources, reliable sources of information
B. Conceptual knowledge—The interrelationships among the basic elements within a larger structure that enable them to function together	
Ba. Knowledge of classifications and categories	Periods of geological time, forms of business ownership
Bb. Knowledge of principles and generalizations	Pythagorean theorem, law of supply and demand
Bc. Knowledge of theories, models, and structures	Theory of evolution, structure of Congress
C. Procedural knowledge—How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods	
Ca. Knowledge of subject-specific skills and algorithms	Skills used in painting with watercolors, whole-number division algorithm
Cb. Knowledge of subject-specific techniques and methods	Interviewing techniques, scientific method
Cc. Knowledge of criteria for determining when to use appropriate procedures	Criteria used to determine when to apply a procedure involving Newton's second law, criteria used to judge the feasibility of using a particular method to estimate business costs
D. Metacognitive knowledge—Knowledge of cognition in general as well as awareness and knowledge of one's own cognition	
Da. Strategic knowledge	Knowledge of outlining as a means of capturing the structure of a unit of subject matter in a textbook, knowledge of the use of heuristics
Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge	Knowledge of the types of tests particular teachers administer, knowledge of the cognitive demands of different tasks
Dc. Self-knowledge	Knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one's own knowledge level

not the same as knowledge that is defined consensually by experts. This issue is discussed in more detail in Chapter 4.

Categories of the Cognitive Process Dimension

The categories of the cognitive process dimension are intended to provide a comprehensive set of classifications for those student cognitive processes that are included in objectives. As shown in Table 3.1, the categories range from the cognitive processes most commonly found in objectives, those associated with *Remember*, through *Understand* and *Apply*, to those less frequently found, *Analyze*, *Evaluate*, and *Create*. *Remember* means to retrieve relevant knowledge from long-term memory. *Understand* is defined as constructing the meaning of instructional messages, including oral, written, and graphic communication. *Apply* means carrying out or using a procedure in a given situation. *Analyze* is breaking material into its constituent parts and determining how the parts are related to one another as well as to an overall structure or purpose. *Evaluate* means making judgments based on criteria and/or standards. Finally, *Create* is putting elements together to form a novel, coherent whole or to make an original product.

Each of the six major categories is associated with two or more specific cognitive processes, 19 in all, also described by verb forms (see Table 3.3). To differentiate the specific cognitive processes from the six categories, the specific cognitive processes take the form of gerunds, ending in "ing." Thus, *recognizing* and *recalling* are associated with *Remember; interpreting, exemplifying, classifying, summarizing, inferring, comparing,* and *explaining* are associated with *Understand; executing* and *implementing* with *Apply;* and so on.

The Taxonomy Table and Objectives: A Diagrammatic Summary

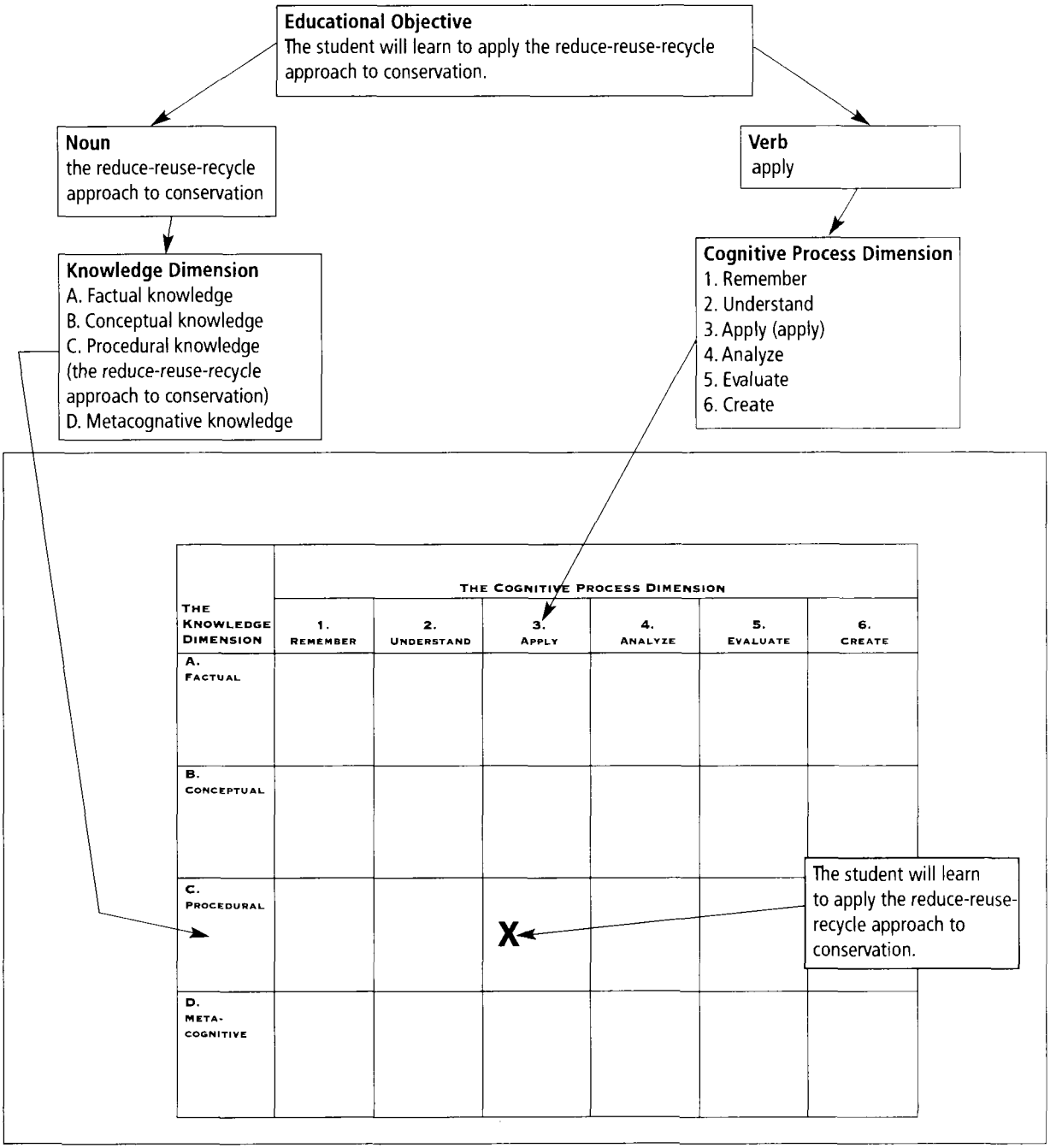
Figure 3.1 depicts the analytic journey from the statement of an objective to its placement in the Taxonomy Table. The journey begins by locating the verb and noun in the objective. The verb is examined in the context of the six categories of the cognitive process dimension: *Remember, Understand, Apply, Analyze, Evaluate,* and *Create.* Placing the verb into the appropriate category is usually facilitated by focusing initially on the 19 specific cognitive processes, rather than on the larger categories. Likewise, the noun is examined in the context of the four types in the knowledge dimension: *Factual, Conceptual, Procedural,* and *Metacognitive.* Again, focusing initially on the subtypes within the knowledge categories typically aids in the proper placement. One can classify the objective as initially stated, as it was taught, and as it was assessed, and ask whether these classifications are aligned. This latter process is illustrated in the vignettes in Chapters 8–13.

Consider the rather straightforward example shown in Figure 3.1: "The student will learn to apply the reduce-reuse-recycle approach to conservation."

3.3 The Six Categories of the Cognitive Process Dimension and Related Cognitive Processes*

Process Categories	Cognitive Processes and Examples
1. REMEMBER—Retrieve relevant knowledge from long-term memory.	
1.1 Recognizing	(e.g., Recognize the dates of important events in U.S. history)
1.2 Recalling	(e.g., Recall the dates of important events in U.S. history)
2. UNDERSTAND—Construct meaning from instructional messages, including oral, written, and graphic communication.	
2.1 Interpreting	(e.g., Paraphrase important speeches and documents)
2.2 Exemplifying	(e.g., Give examples of various artistic painting styles)
2.3 Classifying	(e.g., Classify observed or described cases of mental disorders)
2.4 Summarizing	(e.g., Write a short summary of the events portrayed on videotapes)
2.5 Inferring	(e.g., In learning a foreign language, infer grammatical principles from examples)
2.6 Comparing	(e.g., Compare historical events to contemporary situations)
2.7 Explaining	(e.g., Explain the causes of important eighteenth-century events in France)
3. APPLY—Carry out or use a procedure in a given situation.	
3.1 Executing	(e.g., Divide one whole number by another whole number, both with multiple digits)
3.2 Implementing	(e.g., Determine in which situations Newton's second law is appropriate)
4. ANALYZE—Break material into constituent parts and determine how parts relate to one another and to an overall structure or purpose.	
4.1 Differentiating	(e.g., Distinguish between relevant and irrelevant numbers in a mathematical word problem)
4.2 Organizing	(e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)
4.3 Attributing	(e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)
5. EVALUATE—Make judgments based on criteria and standards.	
5.1 Checking	(e.g., Determine whether a scientist's conclusions follow from observed data)
5.2 Critiquing	(e.g., Judge which of two methods is the best way to solve a given problem)
6. CREATE—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure.	
6.1 Generating	(e.g., Generate hypotheses to acount for an observed phenomenon)
6.2 Planning	(e.g., Plan a research paper on a given historical topic)
6.3 Producing	(e.g., Build habitats for certain species for certain purposes)

FIGURE 3.1 HOW AN OBJECTIVE (THE STUDENT WILL LEARN TO APPLY THE REDUCE-REUSE-RECYCLE APPROACH TO CONSERVATION) IS CLASSIFIED IN THE TAXONOMY TABLE



The verb is "apply." Since *Apply* is one of the six cognitive process categories, we have to look no further than the six categories in this example. The noun phrase is "the reduce-reuse-recycle approach to conservation." An approach is a method or technique, and in Table 3.2 methods and techniques are associated with *Procedural knowledge.* Thus, this objective is placed in the cell corresponding to the intersection of *Apply* and *Procedural knowledge.*

Unfortunately, classifying objectives is often more difficult than this example suggests. There are two reasons for this difficulty. The first is that statements of objectives may contain more than verbs and nouns. In the objective "The student will be able to give examples of the law of supply and demand in the local community," for example, the phrase "in the local community" is extraneous for our classification. The verb is "exemplify" (i.e., "to give examples") and the noun phrase is "the law of supply and demand." The phrase "in the local community" establishes the conditions within which the examples must be selected.

Consider a third objective: "The student will be able to produce original works that meet the criteria of appropriate oral and written forms." The verb is "produce" and the noun is "criteria." The phrase "of appropriate oral and written forms" simply clarifies the meaning of "criteria." So, modifying phrases or clauses should be ignored in classifying the objective; they may cause confusion when one is attempting to identify relevant parts for categorizing.

The second reason for the difficulty in classifying objectives is that the verb may be ambiguous in terms of the intended cognitive process or the noun may be ambiguous in its intended knowledge. Consider the following objective: "The student will learn to describe changes in matter and the causes of those changes." "Describe" can mean many things. Students can describe what they have recalled, interpreted, explained, or generated. *Recalling, interpreting, explaining,* and *generating* are quite different processes. One would have to infer which process the teacher intended in order to classify the objective.

Similarly, in some statements of objectives, the noun tells us little if anything about the relevant knowledge. This is a particular problem with objectives that address more complex cognitive processes. Consider the following objective: "The student will be able to evaluate editorials in newspapers and news magazines." The verb is "evaluate," and the noun phrase is "editorials in newspapers and news magazines." As we discussed in Chapter 2, editorials are curricular or instructional materials, not knowledge. In this case, the knowledge is implicit—namely, the criteria students should use to evaluate the editorials (e.g., presence or absence of bias, clarity of point of view, logic of the argument). So, the objective should be classified as *Evaluate* and *Conceptual knowledge.*

It should now be evident that the people who are classifying objectives must make inferences. Consider the following two objectives; the first is rather straightforward, and the second requires more inference.

The first objective is "The student should be able to plan a unit of instruction for a particular teaching situation" (*Handbook,* p. 171). This objective combines the unit plan (the noun) with the act of planning (the verb). Where does this objective fit in the Taxonomy Table? Plans are *models* that guide future

actions. Referring back to Table 3.2, we see that "models" appears in the third subtype of *Conceptual knowledge,* the second row of the Taxonomy Table (i.e., row B). Referring to Table 3.3, we see that "planning" is the second cognitive process within *Create,* the sixth column of the Taxonomy Table (i.e., column 6). Our analysis suggests that the objective falls into the cell corresponding to the intersection of row B, *Conceptual knowledge,* and column 6, *Create.* This objective, then, has to do with students *creating conceptual knowledge.*

The second objective is "The student should be able to recognize the point of view or bias of a writer of a historical account" (*Handbook,* p. 148). In this case, the noun is "historical account." Like textbooks and essays, a historical account is best considered curricular or instructional material. The question remains, then, what type of knowledge is involved. We suggest two possibilities: *Factual knowledge* or *Conceptual knowledge.* Which type it is depends on (1) the structure of the account, (2) the way the account is "introduced" to the students, or most likely (3) some combination of these. The verb phrase is "recognize the point of view or bias." The verb is *not* "recognize." If it were "recognize," we would place it in the category *Remember.* However, the act of recognizing (i.e., determining) a point of view or bias defines the cognitive process *attributing* (see Table 3.3). *Attributing* is associated with *Analyze,* a category at a much higher level of complexity. So we place the objective somewhere in the fourth column, *Analyze.* Since the knowledge could be either of two types, *Factual knowledge* or *Conceptual knowledge,* we place the objective in two cells, one corresponding to the intersection of *Analyze* and *Factual knowledge* (cell A4) and the other to the intersection of *Analyze* and *Conceptual knowledge* (cell B4).

To confuse matters even further, the teacher could teach students **how to** recognize points of view or biases, and this would be *Procedural knowledge.* Since students would be expected to **use** the *Procedural knowledge* (as taught to them) with the historical account, the cognitive process category would likely shift from *Analyze* to *Apply.* Now the objective would be placed in cell C3.

In summary, then, the Taxonomy Table can be used to categorize objectives, provided that the person or persons doing the categorization make correct inferences. Because inference is involved and because each person may have access to different information, individuals may disagree about the correct classification of an objective. As seen throughout this chapter, the most obvious source of information is the objective as stated, but the stated objective and the objective as taught and assessed may differ. So, other sources of information to be considered are observations of classrooms, examinations of test items and other assessment tasks, and discussions with or among teachers. From our experience, using multiple sources of information is likely to result in the most valid, defensible classification of objectives.

Why Categorize Objectives?

Why would anyone want to categorize objectives? What is the point of using our framework to guide the classification? We offer six answers to these questions. The first is that *categorization within our framework permits educators to examine objectives from the student's point of view.* What is it that students must

know and be able to do in order to achieve a particular objective? Will a "grocery list" of discrete facts suffice (*Factual knowledge*), or do students need some cohesive structure that holds these facts together (*Conceptual knowledge*)? Do students need to be able to classify (*Understand*), to differentiate (*Analyze*), or to do both? We typically ask these questions as we work with objectives within our framework in an attempt to answer the "learning question" (see Chapter 1).

Our second answer is that *categorization within our framework helps educators consider the panorama of possibilities in education.* This was one of the primary values of the original *Handbook,* raising the possibility of teaching for so-called higher-order objectives. Our revision adds the possibility and desirability of objectives that emphasize *Metacognitive knowledge.* Metacognitive knowledge is empowering to students and is an important basis for "learning how to learn" (Bransford, Brown, and Cocking, 1999). Classifying objectives for this purpose once again helps us address the "learning question."

The third answer is that *categorization within our framework helps educators see the integral relationship between knowledge and cognitive processes inherent in objectives.* Can students realistically be expected to *apply factual knowledge,* or is it easier for them if they are helped to *understand procedural knowledge* before they attempt to apply it? Can students learn to *understand conceptual knowledge* by having them *analyze factual knowledge*? These are the types of questions we ask as we struggle to answer the "instruction question."

Our fourth answer to the question of why anyone would want to categorize objectives is consistent with the original *Handbook: It makes life easier!* With the Taxonomy in place, examiners do not have to approach every objective as a unique entity. Rather, they can say to themselves, "Oh, this is an analysis objective. I know how to write examination items for analysis objectives." They can pull out their "templates" (the sample test items in the *Handbook*) and, with modifications dictated by differences in subject matters, write several items in a fairly short time. Thus, by classifying objectives we are more able to deal with the "assessment question."

Likewise, we expect those who use the Taxonomy Table to come to a common realization: "Oh, this is an objective that emphasizes *understanding conceptual knowledge.* I know how to teach for *Conceptual knowledge* objectives. I could focus on critical attributes of the concept. For many kinds of *Conceptual knowledge,* I could include examples and nonexamples. I may want to embed a particular concept within a larger conceptual framework and discuss similarities and differences within the framework." Similar statements can be made for assessment: "I could design assessment tasks that require students to *exemplify* and *classify.* I need to ensure that the assessment tasks are not identical to those in the textbook or those I used during class." So, once again, classifying objectives helps us deal with the "instruction and assessment questions."

Our fifth answer is that *categorization makes more readily apparent the consistency, or lack of it, among the stated objectives for a unit, the way it was taught, and how learning was assessed.* Comparisons of the categorizations based on stated objectives, instructional activities, and assessment tasks show whether these phases of the educational experience are congruent with one another both in their nature and in their relative emphasis. An important caveat was suggested,

however, by a teacher, Melody Shank, who reviewed an earlier draft of our revision (personal communication, 1998):

> I can imagine teachers fretting over whether they placed their objectives, activities, and assessments in the proper cell . . . instead of thoughtfully examining their implicit and explicit objectives, planned activities, and assessments. Becoming aware of whether their planned activities are aligned with their intended (stated or intuited) objectives and how they might adjust those activities is the important activity, not whether they have each component instructional part in the proper cell. . . . I would want teachers to have thoughtful, productive discussion throughout the analysis, rather than arguments about the proper placement of the items in the table.

This comment states well the emphasis that we place on the use of the Taxonomy Table and that will be exemplified in the later analysis of the vignettes. So, classifying objectives helps educators deal with the "alignment question."

The sixth and final answer is that *categorization within our framework helps educators make better sense of the wide variety of terms that are used in education.* Our 19 cognitive processes have very specific meanings. *Inferring* requires that students recognize some pattern in the information given, whereas *explaining* requires a search for causality in that pattern. *Implementing* requires adjusting a process to a new situation; *executing* does not. *Generating* requires divergent thinking, whereas *organizing* requires convergence. *Checking* concerns internal consistency; *critiquing,* consistency with external criteria. To the extent that we can associate other words and terms with our framework, then, we increase their level of precision. With increased precision comes the likelihood for better communication.

Our Use of Multiple Forms of Definition

To be useful, the definitions of the knowledge types and subtypes and the process categories and specific cognitive processes must be understood clearly and precisely. Since multiple kinds of definition tend to contribute to greater understanding, we present four definitional forms in the chapters that follow: verbal descriptions, sample objectives, sample assessment tasks, and sample instructional activities.

Verbal Descriptions

Verbal descriptions are similar to good dictionary definitions. Furthermore, "the exact phrasing of these definitions has been the subject of much debate among us and while the present definitions are far from ideal, every effort has been made to describe the major aspects of each category as carefully as possible" (*Handbook,* p. 44). That statement made by the original group applies to this volume as well. The verbal descriptions are given in Chapters 4 and 5.

Sample Objectives

Sample objectives provide a second means of understanding the categories. The sources of the sample objectives are attributed where they appear. Some were taken from publicly available statements, like those of *Goals 2000* and of the National Council of Teachers of Mathematics, because they typify objectives of interest and concern to many teachers at present. Teachers' editions of textbooks, test publishers' manuals, and vignettes prepared by teachers (see Section III) were additional sources.

Sample Assessment Tasks

The sample assessment tasks in Chapter 5 and the assessments in the vignettes provide yet another means of understanding the categories in our framework. The tasks were chosen to illustrate some ways of assessing combinations of knowledge and cognitive processes. Some people consider the means used to assess learning as the "real" goals of instruction because, regardless of fancy statements, the concrete representation of objectives in tests and other assessments often determines what students study as well as how they study it.

Sample Instructional Activities

The illustrative instructional activities in the vignettes offer our fourth and final way of understanding the categories of the framework. These vignettes provide additional examples of both knowledge and cognitive processes and, perhaps more important, their interplay. In addition to aiding in the understanding of the categories, the vignettes are designed to make the Taxonomy Table more useful and usable for teachers, teacher educators, curriculum developers, assessment specialists, and educational administrators.

Closing Comment: A Look Ahead

Having examined the classification of objectives in the Taxonomy Table, we now turn to a detailed examination of the two dimensions that make up the table: knowledge and cognitive process. The four types of knowledge together with their subtypes are described in Chapter 4. The six major cognitive process categories and the 19 cognitive processes that help define them are described in Chapter 5.