David R. Krathwohl

A Revision of Bloom's Taxonomy: An Overview

THE TAXONOMY OF EDUCATIONAL OBJECTIVES is a framework for classifying statements of what we expect or intend students to learn as a result of instruction. The framework was conceived as a means of facilitating the exchange of test items among faculty at various universities in order to create banks of items, each measuring the same educational objective. Benjamin S. Bloom, then Associate Director of the Board of Examinations of the University of Chicago, initiated the idea, hoping that it would reduce the labor of preparing annual comprehensive examinations. To aid in his effort, he enlisted a group of measurement specialists from across the United States, many of whom repeatedly faced the same problem. This group met about twice a year beginning in 1949 to consider progress, make revisions, and plan the next steps. Their final draft was published in 1956 under the title, *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain* (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956).[1] Hereafter, this is referred to as the original Taxonomy. The revision of this framework, which is the subject of this issue of *Theory Into Practice,* was developed in much the same manner 45 years later (Anderson, Krathwohl, et al., 2001). Hereafter, this is referred to as the revised Taxonomy.[2]

David R. Krathwohl is Hannah Hammond Professor of Education Emeritus at Syracuse University.

Bloom saw the original Taxonomy as more than a measurement tool. He believed it could serve as a

- common language about learning goals to facilitate communication across persons, subject matter, and grade levels;
- basis for determining for a particular course or curriculum the specific meaning of broad educational goals, such as those found in the currently prevalent national, state, and local standards;
- means for determining the congruence of educational objectives, activities, and assessments in a unit, course, or curriculum; and
- panorama of the range of educational possibilities against which the limited breadth and depth of any particular educational course or curriculum could be contrasted.

The Original Taxonomy

The original Taxonomy provided carefully developed definitions for each of the six major categories in the cognitive domain. The categories were *Knowledge, Comprehension, Application, Analysis, Synthesis,* and *Evaluation.*[3] With the exception of *Application*, each of these was broken into subcategories. The complete structure of the original Taxonomy is shown in Table 1.

The categories were ordered from simple to complex and from concrete to abstract. Further, it was assumed that the original Taxonomy represented a cumulative hierarchy; that is, mastery of

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

Table 1
Structure of the Original Taxonomy

1.0 Knowledge
- *1.10 Knowledge of specifics*
  - *1.11 Knowledge of terminology*
  - *1.12 Knowledge of specific facts*
- *1.20 Knowledge of ways and means of dealing with specifics*
  - *1.21 Knowledge of conventions*
  - *1.22 Knowledge of trends and sequences*
  - *1.23 Knowledge of classifications and categories*
  - *1.24 Knowledge of criteria*
  - *1.25 Knowledge of methodology*
- *1.30 Knowledge of universals and abstractions in a field*
  - *1.31 Knowledge of principles and generalizations*
  - *1.32 Knowledge of theories and structures*

2.0 Comprehension
- *2.1 Translation*
- *2.2 Interpretation*
- *2.3 Extrapolation*

3.0 Application

4.0 Analysis
- *4.1 Analysis of elements*
- *4.2 Analysis of relationships*
- *4.3 Analysis of organizational principles*

5.0 Synthesis
- *5.1 Production of a unique communication*
- *5.2 Production of a plan, or proposed set of operations*
- *5.3 Derivation of a set of abstract relations*

6.0 Evaluation
- *6.1 Evaluation in terms of internal evidence*
- *6.2 Judgments in terms of external criteria*

each simpler category was prerequisite to mastery of the next more complex one.

At the time it was introduced, the term *taxonomy* was unfamiliar as an education term. Potential users did not understand what it meant, therefore, little attention was given to the original Taxonomy at first. But as readers saw its potential, the framework became widely known and cited, eventually being translated into 22 languages.

One of the most frequent uses of the original Taxonomy has been to classify curricular objectives and test items in order to show the breadth, or lack of breadth, of the objectives and items across the spectrum of categories. Almost always, these analyses have shown a heavy emphasis on objectives requiring only recognition or recall of information, objectives that fall in the *Knowledge* category. But, it is objectives that involve the understanding and use of knowledge, those that would be classified in the categories from *Comprehension* to *Synthesis,* that are usually considered the most important goals of education. Such analyses, therefore, have repeatedly provided a basis for moving curricula and tests toward objectives that would be classified in the more complex categories.

From One Dimension to Two Dimensions

Objectives that describe intended learning outcomes as the result of instruction are usually framed in terms of (a) some subject matter content and (b) a description of what is to be done with or to that content. Thus, statements of objectives typically consist of a noun or noun phrase—the subject matter content—and a verb or verb phrase—the cognitive process(es). Consider, for example, the following objective: The student shall be able to remember the law of supply and demand in economics. "The student shall be able to" (or "The learner will," or some other similar phrase) is common to all objectives since an objective defines what students are expected to learn. Statements of objectives often omit "The student shall be able to" phrase, specifying just the unique part (e.g., "Remember the economics law of supply and demand."). In this form it is clear that the noun phrase is "law of supply and demand" and the verb is "remember."

In the original Taxonomy, the *Knowledge* category embodied both noun and verb aspects. The noun or subject matter aspect was specified in *Knowledge's* extensive subcategories. The verb aspect was included in the definition given to *Knowledge* in that the student was expected to be able to recall or recognize knowledge. This brought unidimensionality to the framework at the cost of a *Knowledge* category that was dual in nature and thus different from the other Taxonomic categories. This anomaly was eliminated in the revised Taxonomy by allowing these two aspects, the noun and verb, to form separate dimensions, the noun providing the basis for the Knowledge dimension and the verb forming the basis for the Cognitive Process dimension.

The Knowledge dimension

Like the original, the knowledge categories of the revised Taxonomy cut across subject matter lines. The new Knowledge dimension, however, contains four instead of three main categories. Three of them include the substance of the subcategories of Knowledge in the original framework. But they were reorganized to use the terminology, and to recognize the distinctions of cognitive psychology that developed since the original framework was devised. A fourth, and new category, ***Metacognitive Knowledge,*** provides a distinction that was not widely recognized at the time the original scheme was developed. ***Metacognitive Knowledge*** involves knowledge about cognition in general as well as awareness of and knowledge about one's own cognition (Pintrich, this issue). It is of increasing significance as researchers continue to demonstrate the importance of students being made aware of their metacognitive activity, and then using this knowledge to appropriately adapt the ways in which they think and operate. The four categories with their subcategories are shown in Table 2.

The Cognitive Process dimension

The original number of categories, six, was retained, but with important changes. Three categories were renamed, the order of two was interchanged, and those category names retained were changed to verb form to fit the way they are used in objectives.

The verb aspect of the original *Knowledge* category was kept as the first of the six major categories, but was renamed ***Remember***. *Comprehension* was renamed because one criterion for selecting category labels was the use of terms that teachers use in talking about their work. Because *understand* is a commonly used term in objectives, its lack of inclusion was a frequent criticism of the original Taxonomy. Indeed, the original group considered using it, but dropped the idea after further consideration showed that when teachers say they want the student to "really" understand, they mean anything from *Comprehension* to *Synthesis*. But, to the revising authors there seemed to be popular usage in which *understand* was a widespread synonym for comprehending. So, *Comprehension,* the second of the original categories, was renamed ***Understand.***[4]

Table 2
Structure of the Knowledge Dimension of the Revised Taxonomy

A. ***Factual Knowledge*** – The basic elements that students must know to be acquainted with a discipline or solve problems in it.
- **Aa. Knowledge of terminology**
- **Ab. Knowledge of specific details and elements**

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**
- **Bb. Knowledge of principles and generalizations**
- **Bc. Knowledge of theories, models, and structures**

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**
- **Cb. Knowledge of subject-specific techniques and methods**
- **Cc. Knowledge of criteria for determining when to use appropriate procedures**

D. ***Metacognitive Knowledge*** – Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.
- **Da. Strategic knowledge**
- **Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge**
- **Dc. Self-knowledge**

Application, Analysis, and *Evaluation* were retained, but in their verb forms as ***Apply, Analyze,*** and ***Evaluate***. *Synthesis* changed places with *Evaluation* and was renamed ***Create***. All the original subcategories were replaced with gerunds, and called "cognitive processes." With these changes, the categories and subcategories—cognitive processes—of the Cognitive Process dimension are shown in Table 3.

Whereas the six major categories were given far more attention than the subcategories in the original Taxonomy, in the revision, the 19 specific cognitive processes within the six cognitive process categories receive the major emphasis. Indeed, the nature of the revision's six major categories emerges most clearly from the descriptions given the specific cognitive processes. Together, these processes characterize each category's breadth and depth.

Like the original Taxonomy, the revision is a hierarchy in the sense that the six major categories of the Cognitive Process dimension are believed to differ in their complexity, with *remember* being less complex than *understand,* which is less complex than *apply,* and so on. However, because the revision gives much greater weight to teacher usage, the requirement of a strict hierarchy has been relaxed to allow the categories to overlap one another. This is most clearly illustrated in the case of the category ***Understand***. Because its scope has been considerably broadened over *Comprehend* in the original framework, some cognitive processes associated with ***Understand*** (e.g., ***Explaining***) are more cognitively complex than at least one of the cognitive processes associated with ***Apply*** (e.g., ***Executing***). If, however, one were to locate the "center point" of each of the six major categories on a scale of judged complexity, they would likely form a scale from simple to complex. In this sense, the Cognitive Process dimension is a hierarchy, and probably one that would be supported as well as was the original Taxonomy in terms of empirical evidence (see Anderson, Krathwohl, et al., 2001, chap. 16).

Table 3
Structure of the Cognitive Process Dimension of the Revised Taxonomy

1.0 Remember – Retrieving relevant knowledge from long-term memory.
- ***1.1 Recognizing***
- ***1.2 Recalling***

2.0 Understand – Determining the meaning of instructional messages, including oral, written, and graphic communication.
- ***2.1 Interpreting***
- ***2.2 Exemplifying***
- ***2.3 Classifying***
- ***2.4 Summarizing***
- ***2.5 Inferring***
- ***2.6 Comparing***
- ***2.7 Explaining***

3.0 Apply – Carrying out or using a procedure in a given situation.
- ***3.1 Executing***
- ***3.2 Implementing***

4.0 Analyze – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
- ***4.1 Differentiating***
- ***4.2 Organizing***
- ***4.3 Attributing***

5.0 Evaluate – Making judgments based on criteria and standards.
- ***5.1 Checking***
- ***5.2 Critiquing***

6.0 Create – Putting elements together to form a novel, coherent whole or make an original product.
- ***6.1 Generating***
- ***6.2 Planning***
- ***6.3 Producing***

The Taxonomy Table

In the revised Taxonomy, the fact that any objective would be represented in two dimensions immediately suggested the possibility of constructing a two-dimensional table, which we termed the Taxonomy Table. The Knowledge dimension would form the vertical axis of the table, whereas the Cognitive Process dimension would form the horizontal axis. The intersections of the knowledge and cognitive process categories would form the cells. Consequently, any objective could be classified in the Taxonomy Table in one or more cells that correspond with the intersection of the column(s) appropriate for categorizing the verb(s) and the row(s) appropriate for categorizing the noun(s) or noun phrase(s). To see how this placement of objectives is accomplished, consider the following example adapted from the State of Minnesota's Language Arts Standards for Grade 12:

> A student shall demonstrate the ability to write using grammar, language mechanics, and other conventions of standard written English for a variety of academic purposes and situations by writing original compositions that analyze patterns and relationships of ideas, topics, or themes. (State of Minnesota, 1998)

We begin by simplifying the standard (i.e., objective) by ignoring certain parts, particularly restrictions such as "using grammar, language mechanics, and other conventions of standard written English for a variety of academic purposes and situations." (Some of these specify scoring dimensions that, if not done correctly, would cause the student's composition to be given a lower grade.) Omitting these restrictions leaves us with the following:

Write original compositions that analyze patterns and relationships of ideas, topics, or themes.

Placement of the objective along the Knowledge dimension requires a consideration of the noun phrase "patterns and relationships of ideas, topics, or themes." "Patterns and relationships" are associated with ***B. Conceptual Knowledge***. So we would classify the noun component as an example of ***B. Conceptual Knowledge.*** Concerning the placement of the objective along the Cognitive Process dimension, we note there are two verbs: write and analyze. Writing compositions calls for ***Producing***, and, as such, would be classified as an example of ***6. Create***. Analyze, of course, would be ***4. Analyze***. Since both categories of cognitive processes are likely to be involved (with students being expected to analyze before they create), we would place this objective in two cells of the Taxonomy Table: B4, Analyze Conceptual Knowledge, and B6, Create [based on] Conceptual Knowledge (see Figure 1). We use the bracketed [based on] to indicate that the creation itself isn't conceptual knowledge; rather, the creation is primarily based on, in this case, conceptual knowledge.

By using the Taxonomy Table, an analysis of the objectives of a unit or course provides, among other things, an indication of the extent to which more complex kinds of knowledge and cognitive processes are involved. Since objectives from ***Understand*** through ***Create*** are usually considered the most important outcomes of education, their inclusion, or lack of it, is readily apparent from the Taxonomy Table. Consider this example from one of the vignettes in the revised Taxonomy volume in which a teacher, Ms. Gwendolyn Airasian, describes a classroom unit in which she integrates Pre-Revolutionary War colonial history with a persuasive writing assignment. Ms. Airasian lists four specific objectives. She wants her students to:

1. Remember the specific parts of the Parliamentary Acts (e.g., the Sugar, Stamp, and Townshend Acts);
2. Explain the consequences of the Parliamentary Acts for different colonial groups;
3. Choose a colonial character or group and write a persuasive editorial stating his/her/its position on the Acts (the editorial must include at least one supporting reason not specifically taught or covered in the class); and
4. Self- and peer edit the editorial.

Categorizing the first objective, ***1. Remember*** is clearly the cognitive process, and "specific parts of the Parliamentary Acts" is ***Ab. Knowledge of specific details or elements,*** a subcategory of ***A. Factual Knowledge***. So this objective is placed in cell A1.[5] "Explain," the verb in the second objective, is the seventh cognitive process, ***2.7 Explaining,***

The Cognitive Process Dimension

The Knowledge Dimension	1. ***Remember***	2. ***Understand***	3. ***Apply***	4. ***Analyze***	5. ***Evaluate***	6. ***Create***
A. ***Factual Knowledge***						
B. ***Conceptual Knowledge***				X		X
C. ***Procedural Knowledge***						
D. ***Metacognitive Knowledge***						

Figure 1. The placement in the Taxonomy Table of the State of Minnesota's Language Arts Standard for Grade 12.

under ***2. Understand***. Since the student is asked to explain the "consequences of the Parliamentary Acts," one can infer that "consequences" refers to generalized statements about the Acts' aftereffects and is closest to ***Bc. Knowledge of theories, models, and structures***. The type of knowledge, then, would be ***B. Conceptual Knowledge***. This objective would be classified in cell B2.

The key verb in the third objective is "write." Like the classification of the State of Minnesota's standard discussed above, writing is ***6.3 Producing***, a process within ***6. Create***. To describe "his/her/its position on the Acts" would require some combination of ***A. Factual Knowledge*** and ***B. Conceptual Knowledge***, so this objective would be classified in two cells: A6 and B6. Finally, the fourth objective involves the verbs "self-edit" and "peer edit." Editing is a type of evaluation, so the process involved is ***5. Evaluate***. The process of evaluation will involve criteria, which are classified as ***B. Conceptual Knowledge***, so the fourth objective would fall in cell B5. The completed Taxonomy Table for this unit's objectives is shown in Figure 2.

From the table, one can quickly visually determine the extent to which the more complex categories are represented. Ms. Airasian's unit is quite good in this respect. Only one objective deals with the ***Remember*** category; the others involve cognitive processes that are generally recognized as the more important and long-lasting fruits of education—the more complex ones.

In addition to showing what was included, the Taxonomy Table also suggests what might have been but wasn't. Thus, in Figure 2, the two blank bottom rows raise questions about whether there might have been procedural or metacognitive knowledge objectives that could have been included. For example, are there procedures to follow in editing that the teacher could explicitly teach the students? Alternatively, is knowledge of the kinds of errors common in one's own writing and preferred ways of correcting them an important metacognitive outcome of self-editing that could have been emphasized? The panorama of possibilities presented by the Taxonomy Table causes one to look at blank areas and reflect on missed teaching opportunities.

The Taxonomy Table can also be used to classify the instructional and learning activities used to achieve the objectives, as well as the assessments employed to determine how well the objectives were mastered by the students. The use of the Taxonomy Table for these purposes is described and illustrated in the six vignettes contained in the revised Taxonomy volume (Anderson, Krathwohl, et al., 2001, chaps. 8-13). In the last two articles of this issue, Airasian discusses assessment in greater detail, and Anderson describes and illustrates alignment.

The Cognitive Process Dimension

The Knowledge Dimension	1. ***Remember***	2. ***Understand***	3. ***Apply***	4. ***Analyze***	5. ***Evaluate***	6. ***Create***
A. ***Factual Knowledge***	Objective 1					Objective 3
B. ***Conceptual Knowledge***		Objective 2			Objective 4	Objective 3
C. ***Procedural Knowledge***						
D. ***Metacognitive Knowledge***						

Figure 2. The classification in a Taxonomy Table of the four objectives of Ms. Airasian's unit integrating Pre-Revolutionary War colonial history with a persuasive writing assignment.

Conclusion

The Taxonomy of Educational Objectives is a scheme for classifying educational goals, objectives, and, most recently, standards. It provides an organizational structure that gives a commonly understood meaning to objectives classified in one of its categories, thereby enhancing communication. The original Taxonomy consisted of six categories, nearly all with subcategories. They were arranged in a cumulative hierarchical framework; achievement of the next more complex skill or ability required achievement of the prior one. The original Taxonomy volume emphasized the assessment of learning with many examples of test items (largely multiple choice) provided for each category.

Our revision of the original Taxonomy is a two-dimensional framework: Knowledge and Cognitive Processes. The former most resembles the subcategories of the original *Knowledge* category. The latter resembles the six categories of the original Taxonomy with the *Knowledge* category named ***Remember***, the *Comprehension* category named ***Understand***, *Synthesis* renamed ***Create*** and made the top category, and the remaining categories changed to their verb forms: ***Apply***, ***Analyze***, and ***Evaluate***. They are arranged in a hierarchical structure, but not as rigidly as in the original Taxonomy.

In combination, the Knowledge and Cognitive Process dimensions form a very useful table, the Taxonomy Table. Using the Table to classify objectives, activities, and assessments provides a clear, concise, visual representation of a particular course or unit. Once completed, the entries in the Taxonomy Table can be used to examine relative emphasis, curriculum alignment, and missed educational opportunities. Based on this examination, teachers can decide where and how to improve the planning of curriculum and the delivery of instruction.

Notes

1. *The Taxonomy of Educational Objectives: Handbook II, The Affective Domain* was published later (Krathwohl, Bloom, & Masia, 1964). A taxonomy for the psychomotor domain was never published by the originating group, but some were published by Simpson (1966), Dave (1970), and Harrow (1972).
2. The revised Taxonomy is published both in a hardcover complete edition and a paperback abridgment, which omits Chapters 15, The Taxonomy in Relation to Alternative Frameworks; 16, Empirical Studies of the Structure of the Taxonomy; 17, Unsolved Problems; and Appendix C, Data Used in the Meta-Analysis in Chapter 15.
3. Terms appearing in the original Taxonomy appear in italics with initial caps; terms in the revised Taxonomy add boldface to these specifications.
4. *Problem solving* and *critical thinking* were two other terms commonly used by teachers that were also considered for inclusion in the revision. But unlike *understand*, there seemed to be no popular usage that could be matched to a single category. Therefore, to be categorized in the Taxonomy, one must determine the intended specific meaning of *problem solving* and *critical thinking* from the context in which they are being used.
5. One can use the subcategories to designate the rows and columns; however, for the sake of simplicity, the examples make use of only the major categories.

References

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

Bloom, B.S. (Ed.), Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* New York: David McKay.

Dave, R.H. (1970). Psychomotor levels. In R.J. Armstrong (Ed.), *Developing and writing educational objectives* (pp. 33-34). Tucson AZ: Educational Innovators Press.

Harrow, A.J. (1972). *A taxonomy of the psychomotor domain: A guide for developing behavioral objectives.* New York: David McKay.

Krathwohl, D.R., Bloom, B.S., & Masia, B.B. (1964). *Taxonomy of educational objectives: The classification of educational goals. Handbook II: The affective domain.* New York: David McKay.

Simpson, B.J. (1966). The classification of educational objectives: Psychomotor domain. *Illinois Journal of Home Economics, 10*(4), 110-144.

State of Minnesota. (1998). State educational standards coupled to lesson plans and resources: Language Arts, High standards (1998): Grade 12: Writing-Unit: Description, Academic. Retrieved April 20, 2001, from http://www.statestandards.com/showstate.asp?st=mn.

Paul R. Pintrich

The Role of Metacognitive Knowledge in Learning, Teaching, and Assessing

As Krathwohl (this issue) states, the revised Taxonomy contains four general knowledge categories: Factual, Conceptual, Procedural, and Metacognitive. While the first three categories were included in the original Taxonomy, the Metacognitive Knowledge category was added. The purpose of this article is to discuss the Metacognitive Knowledge category and its implications for learning, teaching, and assessing in the classroom.

Metacognitive knowledge involves knowledge about cognition in general, as well as awareness of and knowledge about one's own cognition. One of the hallmarks of psychological and educational theory and research on learning since the original Taxonomy was published is the emphasis on helping students become more knowledgeable of and responsible for their own cognition and thinking. This change cuts across all the different theoretical approaches to learning and development—from neo-Piagetian models, to cognitive science and information processing models, to Vygotskian and cultural or situated learning models. Regardless of their theoretical perspective, researchers agree that with development students become more aware of their own thinking as well as more knowledgeable about cognition in general. Furthermore, as they act on this awareness they tend to learn better (Bransford, Brown, & Cocking, 1999). The labels for this general developmental trend vary from theory to theory, but they include the development of metacognitive knowledge, metacognitive awareness, self-awareness, self-reflection, and self-regulation.

Paul R. Pintrich is a professor of education at the University of Michigan.

Although there are many definitions and models of metacognition, an important distinction is one between (a) knowledge of cognition and (b) the processes involving the monitoring, control, and regulation of cognition (e.g., Bransford et al, 1999; Brown, Bransford, Ferrara, & Campione, 1983; Flavell, 1979; Paris & Winograd, 1990; Pintrich, Wolters, & Baxter, 2000; Schneider & Pressley, 1997). This basic distinction between metacognitive knowledge and metacognitive control or self-regulatory processes parallels the two dimensions in our Taxonomy Table.

Metacognitive knowledge includes knowledge of general strategies that might be used for different tasks, knowledge of the conditions under which these strategies might be used, knowledge of the extent to which the strategies are effective, and knowledge of self (Flavell, 1979; Pintrich et al., 2000; Schneider & Pressley, 1997). For example, learners can know about different strategies for reading a textbook as well as strategies to monitor and check their comprehension as they read. Learners also activate relevant knowledge about their own strengths and weaknesses pertaining to the task as well as their motivation for completing the task. Suppose learners realize they already know a fair amount about the topic of a chapter in a textbook (which they may perceive as a strength), and that they are interested in this topic (which may enhance their motivation). This realization could lead them to change their approach to the task, such as adjusting their reading approach or rate. Finally, learners also can activate the relevant situational or conditional knowledge for solving a problem in a certain context (e.g., in this classroom; on this type of test; in this type of real-life situation, etc.). They may know, for example, that multiple-choice tests require only recognition of the correct answers, not actual recall of the information, as required in essay tests. This type of metacognitive knowledge might influence how they subsequently prepare for an examination.

In contrast, metacognitive control and self-regulatory processes are cognitive processes that learners use to monitor, control, and regulate their cognition and learning. As such, they fit under the six cognitive process categories and specific cognitive processes in the revised Taxonomy. The metacognitive and self-regulatory processes are well represented in tasks such as checking, planning, and generating. Accordingly, on the Knowledge dimension, Metacognitive Knowledge categories refer only to knowledge of cognitive strategies, not the actual use of those strategies.

Three Types of Metacognitive Knowledge

In Flavell's (1979) classic article on metacognition, he suggested that metacognition included knowledge of strategy, task, and person variables. We represented this general framework in our categories by including students' knowledge of general strategies for learning and thinking (Da - Strategic knowledge) and their knowledge of cognitive tasks as well as when and why to use these different strategies (Db - Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge). Finally, we included knowledge about the self (the person variable) in relation to both cognitive and motivational components of performance (Dc - Self-knowledge).

Strategic knowledge

Strategic knowledge is knowledge of general strategies for learning, thinking, and problem solving. These strategies are applicable across all or most academic disciplines or subject matter domains in contrast to more specific strategies from the disciplines or domains. Consequently, these strategies can be used across a large number of different tasks and domains, rather than being most useful for one particular type of task in one specific subject area (e.g., solving a quadratic equation in mathematics, applying Ohm's law in science).

Strategic knowledge includes knowledge of the various strategies students might use to memorize material, to extract meaning from text, and to comprehend what they hear in classrooms or what they read in books and other course materials. Although there are a large number of different learning strategies, they can be grouped into three general categories: rehearsal, elaboration, and organizational (Weinstein & Mayer, 1986). Rehearsal strategies refer to the strategy of repeating words or terms to be remembered over and over to oneself, generally not the most effective strategy for learning more complex cognitive processes. In contrast, elaboration strategies include various mnemonics for memory tasks, as well strategies such as summarizing, paraphrasing, and selecting main ideas from texts. These elaboration strategies result in deeper processing of the material to be learned and result in better comprehension and learning than do rehearsal strategies. Finally, organizational strategies include various forms of outlining, concept mapping, and note taking, where the student makes connections between and among content elements. Like elaboration strategies, these organizational strategies usually result in better comprehension and learning than rehearsal strategies.

In addition to these general learning strategies, students can have knowledge of various metacognitive strategies that will be useful to them in planning, monitoring, and regulating their learning and thinking. These strategies include ways individuals plan their cognition (e.g., set subgoals), monitor their cognition (e.g., ask themselves questions as they read a piece of text; check their answer to a math problem), and regulate their cognition (e.g., re-read something they don't understand; go back and "repair" their calculating mistake in a math problem). Again, in this category we refer to students' knowledge of these various strategies, not their actual use.

Finally, there are a number of general strategies for problem solving and thinking. These strategies represent the various heuristics individuals can use to solve problems, particularly ill-defined problems where there is no definitive algorithmic solution. In the problem-solving area they can include the knowledge of means-ends analysis as well as knowledge of working backward from the desired goal state. In terms of thinking, there are a number of general strategies for deductive and inductive thinking, such as evaluating the validity of different logical statements, avoiding circularity in arguments, making appropriate inferences from different sources of data, and drawing on appropriate samples to make inferences.

Knowledge about cognitive tasks

In addition to knowledge about various strategies, individuals also accumulate knowledge about different cognitive tasks. Knowledge of tasks includes knowledge that different tasks can be more or less difficult and may require different cognitive strategies. A recall task is more difficult than a recognition task, for example, because in the recall task, the individual must actively search memory and retrieve the relevant information; while in the recognition task, the emphasis is on discriminating among alternatives and selecting the appropriate answer.

As students develop their knowledge of different learning and thinking strategies and their use, this knowledge reflects the "what" and "how" of the different strategies. However, this knowledge may not be enough for expertise in learning. Students also must develop some knowledge about the "when" and "why" of using these strategies appropriately (Paris, Lipson, & Wixson, 1983). Because not all strategies are appropriate for all situations, the learner must develop some knowledge of the different conditions and tasks where the different strategies are used most appropriately.

If one thinks of strategies as cognitive "tools" that help learners construct their understanding, then just as the carpenter uses a variety of different tools for all the tasks that go into building a house, the learner must use different tools for different cognitive tasks. Of course one tool, such as a hammer, can be used in different ways for different tasks, but this is not necessarily the most adaptive use of the hammer—particularly if there are other tools that are better suited to the task. In the same way, specific learning and thinking strategies are better suited to different tasks. For example, if one confronts a novel problem that is ill-defined, then general problem-solving heuristics may be very useful. In contrast, if one confronts a physics problem regarding the second law of thermodynamics, more specific procedural knowledge, not general metacognitive knowledge, will be much more useful and adaptive for this task. An important aspect of learning about strategies is the knowledge of when and why to use them appropriately.

Another important aspect of conditional knowledge concerns the local situational and general social, conventional, and cultural norms for the use of different strategies. For example, a teacher may encourage the use of certain strategies for reading. A student who knows the teacher's strategic preferences is better able to adapt to the demands of this teacher's classroom. In the same manner, different cultures may have norms for the use of different strategies and ways of thinking about problems. Again, knowing these norms can help students adapt to the demands of the culture in terms of solving the problem.

Self-knowledge

Along with knowledge of different strategies and knowledge of cognitive tasks, Flavell (1979) proposed that self-knowledge was an important component of metacognition. Self-knowledge includes knowledge of one's strengths and weaknesses. For example, a student who knows that he or she generally does better on multiple-choice tests than on essay tests has some metacognitive self-knowledge about his or her test-taking ability. This knowledge may be useful to the student as he or she studies for the two different types of tests. One of the hallmarks of experts is that they know when they don't know something and have to rely on some general strategies for finding the appropriate information. This self-awareness of the breadth and depth of one's own knowledge base is an important aspect of self-knowledge. Finally, individuals need to be aware of the different types of strategies they are likely to rely on in different situations. An awareness that one overrelies on a particular strategy when there may be other more adaptive strategies for the task could lead to the possibility of a change in strategy use.

In addition to general self-knowledge, individuals also have beliefs about their motivation. These include judgments of their capability to perform a task (self-efficacy), their goals for completing a task (learning or just getting a good grade), and the interest and value the task has for them (high interest and high value versus low interest and low value). Although these motivational beliefs are usually not considered in cognitive models, there is a fairly substantial body of literature emerging that shows important links between students' motivational beliefs and their cognition and learning (Pintrich & Schrauben, 1992; Pintrich & Schunk, 2002; Snow, Corno, & Jackson, 1996). It seems important that just as students need to develop self-knowledge and self-awareness about their knowledge and cognition, they also need to develop self-knowledge and self-awareness about their motivation.

Although self-knowledge itself can be an important aspect of metacognitive knowledge, it is important to underscore the idea that *accuracy* of self-knowledge seems to be most crucial for learning. That is, we are not advocating that teachers try to boost students' self-esteem (a completely different construct from self-knowledge) by providing students with positive, but false, inaccurate, and misleading feedback about their strengths and weaknesses. It is much more important to have accurate perceptions and judgments of one's knowledge base and expertise than to have inflated and inaccurate self-knowledge (Pintrich & Schunk, 2002). If students do not realize they do not know some aspect of factual, conceptual, or procedural knowledge, it is unlikely they will make any effort to acquire or construct new knowledge. Accordingly, we stress the need for teachers to help students make accurate assessments of their self-knowledge, not inflate their self-esteem.

Implications for Learning, Teaching, and Assessing

Metacognitive knowledge can play an important role in student learning and, by implication, in the ways students are taught and assessed in the classroom (Bransford et al., 1999). First, as previously noted, metacognitive knowledge of strategies and tasks, as well as self-knowledge, is linked to how students will learn and perform in the classroom. Students who know about the different kinds of strategies for learning, thinking, and problem solving will be more likely to use them. After all, if students do not know of a strategy, they will not be able to use it. Students who do know about different strategies for memory tasks, for example, are more likely to use them to recall relevant information. Similarly, students who know about different learning strategies are more likely to use them when studying. And, students who know about general strategies for thinking and problem solving are more likely to use them when confronting different classroom tasks (Bransford et al., 1999; Schneider & Pressley, 1997; Weinstein & Mayer, 1986). Metacognitive knowledge of all these different strategies enables students to perform better and learn more.

In addition, metacognitive knowledge of all these different strategies seems to be related to the transfer of learning; that is, the ability to use knowledge gained in one setting or situation in another (Bransford et al., 1999). Students are often confronted with new tasks that require knowledge and skills they have not yet learned. In this case, they cannot rely solely on their specific prior knowledge or skills to help them on the new task. When experts find themselves in this situation, they are likely to use more general strategies to help them think about or solve the problem. In the same manner, students, who by definition lack expertise in many areas, need to know about different general strategies for learning and thinking in order to use general strategies for new or challenging tasks.

Finally, in terms of learning, self-knowledge can be either an important facilitator or a constraint. Students who know their own strengths and weaknesses can adjust their own cognition and thinking to be more adaptive to diverse tasks and, thus, facilitate learning. If, for example, a student realizes that she does not know very much about a particular topic, she might pay more attention to the topic while reading and use different strategies to make sure she understands the topic being studied. In the same manner, if a student is aware that she has difficulties on certain tests (e.g., mathematics versus history tests), then she can prepare for an upcoming mathematics test in an appropriate manner. Students who lack knowledge of their own strengths and weaknesses will be less likely to adapt to different situations and regulate their own learning in them. For example, if a student reads a text and thinks he understands it, but in reality does not, then he will be less likely to go back and reread or review the text to make sure it is understood. Similarly, a student who believes he understands the material thoroughly will not study for an upcoming test to the same extent as a student who knows he does not understand the material. A student who believes he understands the material when he does not will not do well on the test of that material because he did not study as well as the student who had an accurate perception of his lack of knowledge. Accordingly, lack of self-knowledge can be a constraint on learning.

There are several implications of the relationships among metacognitive knowledge, learning, teaching, and assessing. In terms of instruction, there is a need to teach for metacognitive knowledge *explicitly*. Teachers may do this in some lessons, but in many cases the instruction is more *implicit*. Simply stated, many teachers assume that some students will be able to acquire metacognitive knowledge on their own, while others lack the ability to do so. Of course, some students do acquire metacognitive knowledge through experience and with age, but many more students fail to do so. In our work with college students (see Hofer, Yu, & Pintrich, 1998; Pintrich, McKeachie, & Lin, 1987), we are continually surprised at the number of students who come to college having very little metacognitive knowledge; knowledge about different strategies, different cognitive tasks, and, particularly, accurate knowledge about themselves. Given the fact that students who go on to college are more likely to be better students in general suggests that there is a need to explicitly teach metacognitive knowledge in K-12 settings.

Having said this, it is not our expectation that teachers would teach for metacognitive knowledge in separate courses or separate units, although this can certainly be done (see Hofer et al., 1998; Pintrich et al., 1987). It is more important that metacognitive knowledge is embedded within the usual content-driven lessons in different subject areas. General strategies for thinking and problem solving can be taught in the context of English, mathematics, science, social studies, art, music, and physical education courses. Science teachers, for example, can teach general scientific methods and procedures, but learning will likely be more effective when it is tied to specific science content, not taught in the abstract. Of course, in some skill areas, such as reading or writing, the teaching of metacognitive knowledge about different general strategies for reading comprehension or writing is both acceptable and desirable.

The key is that teachers plan to include some goals for teaching metacognitive knowledge in their regular unit planning, and then actually try to teach and assess for the use of this type of knowledge as they teach other content knowledge. One of the most important aspects of teaching for metacognitive knowledge is the explicit labeling of it for students. For example, during a lesson, the teacher can note occasions when metacognitive knowledge comes up, such as in a reading group discussion of the different strategies students use to read a section of a story. This explicit labeling and discussion helps students connect the strategies (and their names/labels) to other knowledge they may already have about strategies and reading. In addition, making the discussion of metacognitive knowledge part of the everyday discourse of the classroom helps foster a language for students to talk about their own cognition and learning. The shared language and discourse about cognition and learning among peers and between students and teacher helps students become more aware of their own metacognitive knowledge as well as their own strategies for learning and thinking. As they hear and see how their classmates approach a task, they can compare their own strategies with their classmates' and make judgments about the relative utility of different strategies. This type of discourse and discussion helps makes cognition and learning more explicit and less opaque to students, rather than being something that happens mysteriously or that some students "get" and learn and others struggle and don't learn.

In addition to the development of a classroom discourse around metacognitive knowledge, another important instructional strategy is the modeling of strategies, accompanied by an explanation of them. For example, as the teacher is solving a problem for the class, he might talk aloud about his own cognitive processes as he works through the problem. This provides a model for students, showing them how they use strategies in solving real problems. In addition, the teacher also might discuss why he is using this particular strategy for this specific problem, thereby also engaging students in issues concerning the conditional knowledge that governs when and why to use different strategies. As experts in their field, teachers have all kinds of implicit knowledge about strategies and when and why they are appropriate to use; however, students often lack the means to gain access to this knowledge. If the knowledge is never shared through discussion, modeling, or explicit instruction, it is difficult for students to learn.

In terms of implications for assessment, the inclusion of metacognitive knowledge in the revised Taxonomy is not meant to generate the development of separate sections of standardized or formal classroom tests on metacognitive knowledge. Metacognitive knowledge is important in terms of how it is used by students to facilitate their own learning. In this sense, it is more likely that any assessment of metacognitive knowledge by teachers will be informal rather than formal. For example, if teachers are teaching and discussing metacognitive knowledge as part of their normal classroom discourse, they will need to talk to their students about metacognitive knowledge and, perhaps more importantly, actually listen to the students as they talk about their own cognition and learning. As a result of these conversations, teachers will become aware of the general level of metacognitive knowledge in their classrooms and will be able to judge fairly quickly the level and depth of students' metacognitive knowledge. In many respects, this is no different from what teachers do to assess the level of content knowledge their students bring to their classrooms. They start a discussion, ask some questions, listen to the answers, and talk with the students. Based on this discourse, they can quickly estimate the depth of students' prior knowledge. This type of informal assessment can be used to calibrate the instruction to help students gain both content knowledge (whether it be factual, conceptual, or procedural) and metacognitive knowledge.

From these informal "assessment conversations," teachers also may be able to make inferences about the level of metacognitive knowledge of individual students. Just as there is variance in the content knowledge that students bring to the classroom, it is likely there will be a wide distribution of metacognitive knowledge in a class of 20–30 students. This information about individual students can be used to adapt instruction to individual differences. Teachers can talk to students individually or in small groups to estimate levels of metacognitive knowledge. Finally, more formal questionnaires and interview procedures can be used to assess students' metacognitive knowledge concerning their learning strategies as well as their knowledge about different tasks and contexts (see Baker & Cerro, 2000; Pintrich et al., 2000).

As mentioned previously, an important component of metacognitive knowledge is self-knowledge. In terms of assessment, a focus on self-knowledge implies that students should have the opportunity to assess their own strengths and weaknesses. Although this will occasionally happen in larger, public groups, it is important for motivational reasons that self-assessment is more private, occurring between one teacher and one student (see Pintrich & Schunk, 2002). In this way, students are able to meet individually with their teachers to discuss their perceptions of their own strengths and weaknesses, and teachers can provide them with feedback about these perceptions. Portfolio assessment sometimes offers students the opportunity to reflect on their work as represented in the portfolio and this certainly provides self-assessment information to them. As students have more opportunities to reflect on their own learning, they will develop more self-knowledge that can be helpful to them.

Conclusion

In summary, metacognitive knowledge is a new category of knowledge in the revised Taxonomy. However, given its important role in learning, it is a welcome and much-needed addition. Although there are different kinds of metacognitive knowledge, three general types are of particular importance. Strategic knowledge refers to knowledge of strategies for learning and thinking. Knowledge of tasks and their contexts represents knowledge about different types of cognitive tasks as well as classroom and cultural norms. Finally, self-knowledge is a critically important component of metacognitive knowledge. Because metacognitive knowledge in general is positively linked to student learning, explicitly teaching metacognitive knowledge to facilitate its development is needed. As the revised Taxonomy emphasizes, the need to align objectives, instruction, and assessment requires us to consider the role that metacognitive knowledge plays in the classroom.

References

Baker, L., & Cerro, L. (2000). Assessing metacognition in children and adults. In G. Schraw & J. Impara (Eds.), *Issues in the measurement of metacognition* (pp. 99-145). Lincoln, NE: Buros Institute of Mental Measurements.

Bransford, J., Brown, A., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

Brown, A., Bransford, J., Ferrara, R., & Campione, J. (1983). Learning, remembering, and understanding. In P.H. Mussen (Series Ed.) & J. Flavell & E. Markman (Vol. Eds.), *Handbook of child psychology: Vol. 3. Cognitive development* (4th ed., pp. 77-166). New York: Wiley.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34,* 906-911.

Hofer, B., Yu, S., & Pintrich, P.R. (1998). Teaching college students to be self-regulating learners. In D.H. Schunk & B.J. Zimmerman (Eds.), *Self-regulated learning: From teaching to self-reflective practice* (pp. 57-85). New York: Guilford.

Paris, S., Lipson, M., & Wixson, K. (1983). Becoming a strategic reader. *Contemporary Educational Psychology, 8,* 293-316.

Paris, S., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. In B.F. Jones & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 15-51). Hillsdale, NJ: Erlbaum.

Pintrich, P.R., McKeachie, W.J., & Lin, Y. (1987). Teaching a course in learning to learn. *Teaching of Psychology, 14,* 81-86.

Pintrich, P.R., & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom tasks. In D. Schunk & J. Meece (Eds.), *Student perceptions in the classroom: Causes and consequences* (pp. 149-183). Hillsdale, NJ: Erlbaum.

Pintrich, P.R., & Schunk, D.H. (2002). *Motivation in education: Theory, research, and applications.* Upper Saddle River, NJ: Merrill Prentice-Hall.

Pintrich, P.R., Wolters, C., & Baxter, G. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. Impara (Eds.), *Issues in the measurement of metacognition* (pp. 43-97). Lincoln, NE: Buros Institute of Mental Measurements.

Schneider, W., & Pressley, M. (1997). *Memory development between two and twenty.* Mahwah, NJ: Lawrence Erlbaum Associates.

Snow, R., Corno, L., & Jackson, D. (1996). Individual differences in affective and cognitive functions. In D. Berliner & R. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 243-310). New York: Macmillan.

Weinstein, C.E., & Mayer, R. (1986). The teaching of learning strategies. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 315-327). New York: Macmillan.

Richard E. Mayer

Rote Versus Meaningful Learning[1]

LEARNING INVOLVES THE ACQUISITION of knowledge. This is a commonsense view of learning that has implications for how to teach—such as presenting information to learners in books and lectures—and how to assess—such as testing to see how much of the presented material students can remember (Mayer, 2001). The revised Taxonomy is based on a broader vision of learning that includes not only acquiring knowledge but also being able to use knowledge in a variety of new situations. When taking a knowledge acquisition view of learning, teachers sometimes emphasize one kind of cognitive processing in instruction and assessment—what we call *Remembering*. Like the original Taxonomy, however, the revised Taxonomy is based on the idea that schooling can be expanded to include a fuller range of cognitive processes. The purpose of this article is to describe this fuller range of processes in more detail.

Two of the most important educational goals are to promote *retention* and to promote *transfer* (which, when it occurs, indicates meaningful learning). *Retention* is the ability to remember material at some later time in much the same way it was presented during instruction. *Transfer* is the ability to use what was learned to solve new problems, answer new questions, or facilitate learning new subject matter (Mayer & Wittrock, 1996). In short, retention requires that students remember what they have learned, whereas transfer requires students not only to remember but also to make sense of and be able to use what they have learned (Bransford, Brown, & Cocking, 1999; Detterman & Sternberg, 1993; Haskell, 2001; Mayer, 1995; McKeough, Lupart, & Marini, 1995; Phye, 1997). Stated somewhat differently, retention focuses on the past; transfer emphasizes the future. After reading a textbook lesson on Ohm's Law, for example, a retention test might include questions asking students to write the formula for Ohm's Law. In contrast, a transfer test might include questions asking students to rearrange an electrical circuit to maximize the rate of electron flow or to use Ohm's Law to explain a complex electric circuit.

Although educational objectives for promoting retention are fairly easy to construct, educators may have more difficulty in formulating, teaching, and assessing objectives aimed at promoting transfer (Baxter, Elder, & Glaser, 1996; Mayer, 2002; Phye, 1997). The revised Taxonomy is intended to help broaden the typical set of educational objectives to include those aimed at promoting transfer.

Richard E. Mayer is a professor of psychology and education at the University of California, Santa Barbara.

A Tale of Three Learning Outcomes

As an introduction, consider three learning scenarios. The first exemplifies what might be called *no learning*, the second, *rote learning*, and the third, *meaningful learning*.

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

No learning

Amy reads a chapter on electrical circuits in her science textbook. She skims the material, certain that the test will be a breeze. When she is asked to recall part of the lesson (as a retention test), she is able to remember very few of the key terms and facts. For example, she cannot list the major components in an electrical circuit even though they were described in the chapter. When she is asked to use the information to solve problems (as part of a transfer test), she cannot. For example, she cannot answer an essay question that asks her to diagnose a problem in an electrical circuit. In this worst-case scenario, Amy neither possesses nor is able to use the relevant knowledge. Amy has neither sufficiently attended to nor encoded the material during learning. The resulting outcome can be essentially characterized as *no learning*.

Rote learning

Becky reads the same chapter on electrical circuits. She reads carefully, making sure she reads every word. She goes over the material, memorizing the key facts. When she is asked to recall the material, she can remember almost all of the important terms and facts in the lesson. Unlike Amy, she is able to list the major components in an electrical circuit. However, when Becky is asked to use the information to solve problems, she cannot. Like Amy, she cannot answer the essay question requiring her to diagnose a problem in an electrical circuit. In this scenario, Becky possesses relevant knowledge but is unable to use that knowledge to solve problems. She cannot transfer this knowledge to a new situation. Becky has attended to relevant information but has not understood it and, therefore, cannot use it. The resulting learning outcome can be called *rote learning*.

Meaningful learning

Carla reads the same textbook chapter on electrical circuits. She reads carefully, trying to make sense out of it. When asked to recall the material, she, like Midori, can remember almost all of the important terms and facts in the lesson. Furthermore, when she is asked to use the information to solve problems, she generates many possible solutions. In this scenario, Carla not only possesses relevant knowledge, she also can use that knowledge to solve problems and understand new concepts. She can transfer her knowledge to new problems and new learning situations. Carla has attended to relevant information and has understood it. The resulting learning outcome can be called *meaningful learning*.

Meaningful learning occurs when students build the knowledge and cognitive processes needed for successful problem solving. Problem solving involves devising a way of achieving a goal that one has never previously achieved; that is, figuring out how to change a situation from its given state into a goal state (Mayer, 1992). Two major components in problem solving are (a) problem representation, in which a student builds a mental representation of the problem, and (b) problem solution, in which a student devises and carries out a plan for solving the problem (Mayer, 1992).

A focus on meaningful learning is consistent with the view of learning as knowledge construction in which students seek to make sense of their experiences. In constructivist learning, students engage in active cognitive processing, such as paying attention to relevant incoming information, mentally organizing incoming information into a coherent representation, and mentally integrating incoming information with existing knowledge (Mayer, 1999). In contrast, a focus on rote learning is consistent with the view of learning as knowledge acquisition in which students seek to add new information to their memories (Mayer, 1999).

Meaningful learning is recognized as an important educational goal. It requires that instruction go beyond simple presentation of *Factual Knowledge* and that assessment tasks require more of students than simply *recalling* or *recognizing Factual Knowledge* (Bransford, Brown, & Cocking, 1999; Lambert & McCombs, 1998). The cognitive processes summarized here describe the range of students' cognitive activities in meaningful learning; that is, these processes are ways students can actively engage in the process of constructing meaning.

Cognitive Processes for Retention and Transfer

If you are interested mainly in teaching and assessing the degree to which students have learned some subject matter content and retained it over some period of time, you would focus primarily on one class of cognitive processes, namely, those associated with *Remember*. In contrast, if you wish to expand your focus by finding ways to foster and assess meaningful learning, you need to emphasize those cognitive processes that go beyond remembering.

What are some of the cognitive processes used for retention and transfer? As discussed above, the revised Taxonomy includes six cognitive process categories—one most closely related to retention (*Remember*) and the other five increasingly related to transfer (*Understand, Apply, Analyze, Evaluate,* and *Create*). Based on a review of the illustrative objectives listed in the original Taxonomy and an examination of other classification systems, we have selected 19 specific cognitive processes that fit within these six categories. These 19 cognitive processes are intended to be mutually exclusive; together they delineate the breadth and boundaries of the six categories. In the discussion that follows, each of the six categories, as well as the cognitive processes that fit within them, are defined and exemplified.

Remember

When the objective of instruction is to promote retention of the presented material in much the same form in which it was taught, the relevant process category is *Remember*. Remembering involves retrieving relevant knowledge from long-term memory. *Remembering* knowledge is essential for meaningful learning and problem solving when that knowledge is used in more complex tasks. For example, knowledge of the correct spelling of common English words appropriate to a given grade level is necessary if a student is to master writing an essay. When teachers concentrate solely on rote learning, teaching and assessing focus solely on remembering elements or fragments of knowledge, often in isolation from any context. When teachers focus on meaningful learning, however, remembering knowledge is integrated within the larger task of constructing new knowledge or solving new problems. In other words, when meaningful learning is the goal, then remembering becomes a means to an end, rather than the end itself. The two associated cognitive processes are *recognizing* and *recalling*.

Recognizing (also called *identifying*) involves locating knowledge in long-term memory that is consistent with presented material. For example, in social studies, an objective could be "Identify the major exports of various South American countries." A corresponding test item would be "Which of these is a major export of Colombia? (a) bananas, (b) coffee, (c) silk, (d) tea."

Recalling (also called *retrieving*) involves retrieving relevant knowledge from long-term memory. In literature, an objective could be "Recall the poets who authored various poems." A corresponding test question would be "Who wrote *The Charge of the Light Brigade*?"

Understand

As you can see from the previous section, when the goal of instruction is to promote retention, the most important cognitive process is *Remember*. However, when the goal of instruction is to promote transfer, the focus shifts to the other five cognitive process categories, *Understand* through *Create*. Of these, arguably the largest category of transfer-based educational objectives emphasized in schools and colleges is *Understand*. Students are said to *understand* when they are able to construct meaning from instructional messages—including oral, written, and graphic communications, and material presented during lectures, in books, or on computer monitors. Examples of potential instructional messages are an in-class physics demonstration, a geological formation viewed on a field trip, a computer simulation of a trip through an art museum, or a musical work played by an orchestra, as well as numerous verbal, pictorial, and symbolic representations on paper.

Students *understand* when they build connections between the new knowledge to be gained and their prior knowledge. More specifically, the incoming knowledge is integrated with existing schemas and cognitive frameworks. Cognitive processes in the category of *Understand* include *interpreting, exemplifying, classifying, summarizing, inferring, comparing,* and *explaining*.

Interpreting (also called *clarifying, paraphrasing, representing,* or *translating*) occurs when a student is able to convert information from one form of representation to another. In mathematics, for example, a sample objective could be "Learn to translate number sentences expressed in words into algebraic equations expressed in symbols." A corresponding assessment item involves asking students to write an equation (using B for the number of boys and G for the number of girls) that corresponds to the statement, "There are twice as many boys as girls in this class."

Exemplifying (also called *illustrating* or *instantiating*) occurs when a student finds a specific example or instance of a general concept or principle. In art history, an objective might be "Learn to identify various artistic painting styles." A corresponding assessment involves asking students to find a new example of the impressionist style (with *new* meaning an example not included in the textbook or used in class).

Classifying (also called *categorizing* or *subsuming*) occurs when a student determines that something (e.g., a particular instance or example) belongs to a certain category (e.g., concept or principle). In social studies, an objective may be "Learn to classify observed or described cases of mental disorders." A corresponding assessment item is to ask students to observe a video of the behavior of a mental patient and then indicate the mental disorder that is being displayed.

Summarizing (also called *abstracting* or *generalizing*) occurs when a student produces a short statement that represents presented information or abstracts a general theme. The length of the summary depends to a certain extent on the length of the presented material. For example, a sample objective in history could be "Learn to write summaries of events portrayed pictorially." A corresponding assessment item involves asking students to watch a videotape about the French Revolution and then write a cohesive summary.

Inferring (also called *concluding, extrapolating, interpolating,* or *predicting*) involves drawing a logical conclusion from presented information. For example, in learning Spanish as a second language, a sample objective could be "Students will be able to infer grammatical principles from examples." To assess this objective a student may be given the article-noun pairs, "la casa, el muchacho, la senorita, el pero," and asked to formulate a principle for when to use the article *la* and when to use the article *el*.

Comparing (also called *contrasting, mapping,* or *matching*) involves detecting similarities and differences between two or more objects, events, ideas, problems, or situations. In the field of social studies, for example, an objective may be "Understand historical events by comparing them to familiar situations." A corresponding assessment question is "How is the American Revolution like a family fight or an argument between friends?"

Explaining (also called *constructing models*) occurs when a student mentally constructs and uses a cause-and-effect model of a system or series. In natural science, an objective could be "Explain observed phenomena in terms of basic physics laws." Corresponding assessments involve asking students who have studied Ohm's Law to explain what happens to the rate of the current when a second battery is added to a circuit, or asking students who have viewed a video on lightning storms to explain how differences in temperature are involved in the formation of lightning.

Apply

Apply involves using procedures to perform exercises or solve problems and is closely linked with *Procedural Knowledge*. The *Apply* category consists of two cognitive processes: *executing*—when the task is an exercise (i.e., familiar to the learner), and *implementing*—when the task is a problem (i.e., unfamiliar to the learner).

Executing (also called *carrying out*) occurs when a student applies a procedure to a familiar task. For example, a sample objective in elementary level mathematics could be "Learn to divide one whole number by another, both with multiple digits." To assess the objective, a student may be given a worksheet containing 15 whole number division exercises (e.g., 784/15) and asked to find their quotients.

Implementing (also called *using*) occurs when a student applies one or more procedures to an unfamiliar task. In natural science, a sample objective might be "Learn to use the most effective, efficient, and affordable method of conducting a research study to address a specific research question." A corresponding assessment is to give students a research question and have them propose a research study that meets specified criteria of effectiveness, efficiency, and affordability. Notice that in this assessment task, students must not only apply a procedure (i.e., engage in *implementing*) but also rely on conceptual understanding of the problem and procedure. Thus, unlike *executing,* which relies almost exclusively on cognitive processes associated with *Apply, implementing* involves cognitive processes associated with both *Understand* and *Apply*.

Analyze

Analyze involves breaking material into its constituent parts and determining how the parts are related to each other and to an overall structure. This category includes the cognitive processes of *differentiating*, *organizing*, and *attributing*. Therefore, objectives classified as *Analyze* include learning to determine the relevant or important pieces of a message *(differentiating*), the ways in which the pieces of a message are configured (*organizing*), and the underlying purpose of the message (*attributing*). Although learning to *Analyze* may be viewed as an end in itself, it is probably more defensible educationally to consider analysis as an extension of *Understanding* or as a prelude to *Evaluating* or *Creating*.

Improving students' skills in analyzing educational communications can be found as a goal in many fields of study. Teachers of science, social studies, the humanities, and the arts frequently express "learning to analyze" as one of their important objectives. They may, for example, wish to develop in their students the ability to (a) connect conclusions with supporting statements; (b) distinguish relevant from extraneous material; (c) determine how ideas are connected to one another; (d) ascertain the unstated assumptions involved in what is said; (e) distinguish dominant from subordinate ideas or themes in poetry or music; and (f) find evidence in support of an author's purposes for writing an essay.

Differentiating (also called *discriminating, selecting, distinguishing,* or *focusing*) occurs when a student discriminates relevant from irrelevant parts or important from unimportant parts of presented material. In mathematics, an objective could be "Distinguish between relevant and irrelevant numbers in a word problem." An assessment item could require that students circle the relevant numbers and cross out the irrelevant numbers in a word problem.

Organizing (also called *finding coherence, integrating, outlining, parsing,* or *structuring*) involves determining how elements fit or function within a structure. An objective in social studies could be "Learn to structure a historical description into evidence for and against a particular explanation." In a corresponding assessment students could be asked to prepare an outline showing which facts in a passage on American history support and which facts do not support the conclusion that the American Civil War was caused by differences in the rural and urban composition of the North and the South.

Attributing (also called *deconstructing*) occurs when a student is able to determine the point of view, biases, values, or intent underlying presented material. For example, in social studies, a sample objective could be "Learn to determine the point of view of the author of an essay on a controversial topic in terms of his or her theoretical perspective." A corresponding assessment task could ask students whether a report on Amazon rain forests was written from a pro-environment or pro-business point of view. A corresponding assessment in the natural sciences could be to ask a student to determine whether a behaviorist or a cognitive psychologist wrote an essay about human learning.

Evaluate

Evaluate is defined as making judgments based on criteria and standards. The criteria most often used are quality, effectiveness, efficiency, and consistency. They may be determined by the student or given to the student by others. The standards may be either quantitative (i.e., is this a sufficient amount?) or qualitative (i.e., is this good enough?). This category includes the cognitive processes of *checking* (which refers to judgments about internal consistency) and *critiquing* (which refers to judgments based on external criteria).

Checking (also called *coordinating, detecting, monitoring,* or *testing*) occurs when a student detects inconsistencies or fallacies within a process or product, determines whether a process or product has internal consistency, or detects the effectiveness of a procedure as it is being implemented. When combined with *planning* (a cognitive process in the category, *Create*) and *implementing* (a cognitive process in the category, *Apply*), checking involves determining how well the plan is working. A sample objective in social science could be "Learn to detect inconsistencies within persuasive messages." A corresponding assessment task could involve asking students to listen to a television advertisement for a political candidate and point out any logical flaws in the persuasive message. A sample objective in science could be "Learn to determine whether a scientist's conclusion follows from the observed data." An assessment task could involve asking students to read a report of a chemistry experiment in order to determine whether the conclusion follows from the results of the experiment.

Critiquing (also called *judging*) occurs when a student detects inconsistencies between a product or operation and some external criteria, determines whether a product has external consistency, or judges the appropriateness of a procedure for a given problem. *Critiquing* lies at the core of what has been called critical thinking. In *critiquing*, students judge the merits of a product or operation based on specified or student-determined criteria and standards. In social science, an objective could be "Learn to evaluate a proposed solution (e.g., eliminate all grading) to a social problem (e.g., how to improve K-12 education) in terms of its likely effectiveness."

Create

Create involves putting elements together to form a coherent or functional whole; that is, reorganizing elements into a new pattern or structure. Objectives classified as *Create* involve having students produce an original product. Composition (including writing), for example, often, but not always, involves cognitive processes associated with *Create*. It can, in fact, be simply the application of procedural knowledge (e.g., "Write this essay in this way"). The creative process can be broken into three phases: (a) problem representation, in which a student attempts to understand the task and generate possible solutions; (b) solution planning, in which a student examines the possibilities and devises a workable plan; and (c) solution execution, in which a student successfully carries out the plan. Thus, the creative process can be thought of as starting with a divergent phase in which a variety of possible solutions are considered as the student attempts to understand the task (*generating*). This is followed by a convergent phase, in which a solution method is devised and turned into a plan of action (*planning*). Finally, the plan is executed as the solution is constructed (*producing*). Not surprisingly, then, *Create* can be broken down into three cognitive processes: *generating*, *planning*, and *producing*.

Generating (also called *hypothesizing*) involves inventing alternative hypotheses based on criteria. When *generating* transcends the boundaries or constraints of prior knowledge and existing theories, it involves divergent thinking and forms the core of what can be called creative thinking. In *generating*, a student is given a description of a problem and must produce alternative solutions. For example, in social science, an objective could be "Learn to generate multiple potentially useful solutions for social problems." A corresponding assessment item could ask students to suggest as many ways as possible to assure that everyone has adequate medical insurance. An objective from the field of mathematics could be "Generate alternative methods for achieving a particular end result." A corresponding assessment could be to ask students to list alternative methods they could use to find which whole numbers yield 60 when multiplied together. For each of these assessments, explicit scoring criteria are needed.

Planning (also called *designing*) involves devising a method for accomplishing some task. However, *planning* stops short of carrying out the steps to create the actual solution for a given problem. In *planning*, a student may establish subgoals (i.e., break a task into subtasks to be performed when solving the problem). Teachers often skip stating *planning* objectives, instead stating their objectives in terms of *producing*, the final stage of the creative process. When this happens, *planning* is either assumed or is implicit in the *producing* objective. In this case, *planning* is likely to be carried out by the student covertly, in the course of constructing a product (i.e., *producing*). In *planning*, a student develops a solution method when given a problem statement. In mathematics, an objective could be "List the steps needed to solve geometry problems." An assessment task may ask students to devise a plan for determining the volume of the frustum of a pyramid (a task not previously considered in class). The plan may involve computing the volume of a large pyramid, then computing the volume of a small pyramid, and, finally, subtracting the smaller from the larger.

Producing (also called *constructing*) involves inventing a product. In *producing*, a student is given a functional description of a goal and must create a product that satisfies the description. In science, for example, an objective might be "Learn to design habitats for certain species and certain purposes." A corresponding assessment task may ask students to design the living quarters of a space station.

Conclusion

The primary goal of this article has been to examine how teaching and assessing can be broadened beyond an exclusive focus on the cognitive process of *Remember*. The revised Taxonomy contains descriptions of 19 specific cognitive processes associated with six process categories. Two of these cognitive processes are associated with *Remember*; 17 are associated with the five more complex cognitive process categories: *Understand, Apply, Analyze, Evaluate*, and *Create*.

Our analysis has implications for teaching and assessing. On the teaching side, two of the cognitive processes help to promote retention of learning, whereas 17 of them help foster transfer of learning. Thus, when the goal of instruction is to promote transfer, objectives should include the cognitive processes associated with *Understand, Apply, Analyze, Evaluate*, and *Create*. The descriptions in this chapter are intended to help educators generate a more complete range of educational objectives that are likely to result in both retention and transfer.

On the assessment side, our analysis of cognitive processes is intended to help educators (including test designers) broaden the way they assess learning. When the goal of instruction is to promote transfer, assessment tasks should involve cognitive processes that go beyond *recognizing* and *recalling*. Although assessment tasks that use these two cognitive processes have a place in assessment, these tasks can, and often should, be supplemented with those that utilize the full range of cognitive processes required for transfer of learning.

Note

1. This article is based on Chapter 5, The Cognitive Process Dimension in *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (Anderson, Krathwohl, et al., 2001) and is reproduced by permission of the publisher. I am pleased to acknowledge that the following authors contributed to this article: Lorin W. Anderson, David R. Krathwohl, Paul Printrich, and Merlin Wittrock. I also gratefully acknowledge the assistance of the entire team of *Taxonomy* authors.

References

Baxter, G.P., Elder, A.D., & Glaser, R. (1996). Knowledge-based cognition and performance assessment in the science classroom. *Educational Psychologist, 31*, 133-140.

Bransford, J.D., Brown, A.L., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

Detterman, D.K., & Sternberg, R.J. (Eds.). (1993). *Transfer on trial: Intelligence, cognition, and instruction.* Norwood, NJ: Ablex.

Haskell, R.E. (2001). *Transfer of learning*. San Diego: Academic Press.

Lambert, N.M., & McCombs, B.L. (Eds.). (1998). *How students learn.* Washington, DC: American Psychological Association.

Mayer, R.E. (1992). *Thinking, problem solving, cognition* (2nd ed.). New York: Freeman.

Mayer, R.E. (1995). Teaching and testing for problem solving. In L.W. Anderson (Ed.), *International encyclopedia of teaching and teacher education* (2nd ed., pp. 4728-4731). Oxford, UK: Pergamon.

Mayer, R.E. (1999). *The promise of educational psychology.* Upper Saddle River, NJ: Prentice-Hall.

Mayer, R.E. (2001). Changing conceptions of learning: A century of progress in the scientific study of learning. In L. Corno (Ed.), *Education across the century: The centennial volume—One hundredth yearbook of the National Society for the Study of Education* (pp. 34-75). Chicago: National Society for the Study of Education.

Mayer, R.E. (2002). *Teaching for meaningful learning*. Upper Saddle River, NJ: Prentice-Hall.

Mayer, R.E., & Wittrock, M.C. (1996). Problem-solving transfer. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of educational psychology* (pp. 47-62). New York: Macmillan.

McKeough, A., Lupart, J., & Martini, A. (Eds.). (1995). *Teaching for transfer.* Mahwah, NJ: Erlbaum.

Phye, G.D. (Ed.). (1997). *Handbook of classroom assessment.* San Diego: Academic Press.

James Raths

Improving Instruction

WHILE PRESERVICE TEACHER education programs often focus almost exclusively on preparing teacher candidates to cope with the challenges faced during their first year in the classroom, many master's-level programs for teachers emphasize improving instruction. Teachers who enroll in such programs are encouraged to accept the reasonable assumption that all teachers, including the professors in the program, are not perfect in their practice, and that all can improve. Some programs, such as the Master of Instruction program at the University of Delaware, require candidates to write personal goals having to do with improving their instruction as a consideration at the admissions point into the program. This emphasis certainly begs the question: What counts as improved instruction? Stated somewhat differently, if instruction were improved, how would we know it?

What Counts as Improved Instruction?

One answer to this question is reflected in the Carroll (1963) model of school learning.[1] This model posits that student learning is dependent on two variables: the amount of time a student spends learning a task and the amount of time a student *needs* to spend on the task in order to learn or master it. Thus, the amount of learning varies directly with the first variable (time on task) and inversely with the second (time needed to learn). This formula can be written in shorthand form as follows:

Learning = Time on task/Time needed to learn

Carroll's model, so simple and obvious, spawned a great deal of research in the decades after his essay was published. Within the context of the Carroll model, the following can be taken as evidence that instruction has improved:

1. If the amount of learning that takes place in a class increases, all things being equal, then one might reasonably infer that instruction has improved.
2. If students increase their time on task within a lesson or a unit of study, all things being equal, then one might reasonably infer that instruction has improved.
3. If the time students need to learn the objectives of the lesson or unit is reduced because of teacher interventions (e.g., scaffolding), all things being equal, then one might reasonably infer that instruction has improved.
4. If the complexity of the objectives addressed increases across lessons or units, all things being equal, then one might infer that instruction has improved.
5. If the activities assigned to students and the assessments given to students are more closely

James Raths is a professor of education at the University of Delaware.

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

aligned with a lesson's or unit's objectives, all things being equal, then one might reasonably infer that instruction has improved.

Certainly there may be other ways for improving instruction. Examples would include engaging students in increasingly more worthwhile educational experiences; increasing the dispositions of the teacher to convey caring attitudes toward students; linking the topics and objectives of one unit with those of others within the curriculum; and matching instructional activities to learner characteristics (such as cognitive styles). Of course, the Carroll model is so encompassing that even these alternatives can be easily subsumed by the variables within it. Being more caring, for example, could help increase students' time on task. Similarly, providing students with more worthwhile educational experiences could increase students' motivation. Finally, matching instructional activities to students' cognitive styles might reduce the amount of time students need to meet the lesson or unit objectives. The point here is that the Carroll model is only one way to derive conceptions of what counts as instructional improvement.

How Does the Revised Taxonomy Help?

There are at least two ways the revised Taxonomy can help teachers who are interested in improving their instruction and who adopt the Carroll model and the inferences derived from it as described above. The first is to align activities and assessments with objectives. The second is to raise the learning targets themselves.

Aligning objectives, activities, and assessments

As we met to plan and carry out our work on the revised Taxonomy, we soon accepted Benjamin Bloom's assessment that very few people actually read the book in which the original Taxonomy appeared. Instead, they read about the categories of the original Taxonomy in secondary sources, such as methods texts or assessment texts, where the framework is reproduced. We wanted our revision to be read. There was a consensus among us that by including annotated descriptions of teaching to highlight the general propositions found in the revised Taxonomy, we could increase the likelihood that the book would be read. Shortly thereafter, we set about to collect appropriate descriptions of teaching. We were not seeking descriptions of excellent teaching or descriptions authored by teachers who were considered "master teachers" or "national board certified teachers" (although our teachers may well fit into these categories). Rather, we wanted teachers whose descriptions of their everyday teaching could be used to clarify the categories and classifications of the revised Taxonomy.

As we collected the drafts of the vignettes, we found two interesting phenomena. First, as teachers cited their unit's goals, they wrote down activities, not objectives. For example, for a unit combining the Parliamentary Acts (ca. 1770) with persuasive writing, Ms. Gwen Airasian, a fifth grade teacher, wrote as one of her goals "Students will write persuasive editorials stating their opinions about the Parliamentary Acts." We presumed that the actual objective of the unit would be reflected in her answer to the question "What do you want students to learn as a result of writing these editorials?" In short, her *real* objective is more tacit than explicit. It became apparent to us that implicit objectives make the assessment phase of teaching more difficult.

A second phenomenon we observed in the vignettes (and one typically related to the first) was a misalignment within the planning and delivery of the unit between the unit objectives, the instructional activities, and/or the ways in which teachers assessed student learning. Ms. Margaret Jackson's teaching vignette concerning *Macbeth* illustrates this situation. Our analysis found that "although most of the instructional activities emphasize *Conceptual Knowledge*, they differ in the cognitive processes they demand from students. In many cases these demands are beyond *Understanding*, which is the target of the second objective" (Anderson, Krathwohl, et al., 2001, p. 149). Similarly, despite this emphasis on *Conceptual Knowledge*, Ms. Jackson felt compelled to administer a traditional *Factual Knowledge* unit test because of district grading requirements.

The preceding observations have two lessons for potential users of the revised Taxonomy. First, it is critically important to distinguish between objectives and activities. Without this distinction, it is difficult to know what precisely is to be assessed at the end of the unit and how instructional activities and assessment tasks are distinct, yet complementary. Second, it is important to align instructional activities and assessment tasks with objectives, whether they are implicit or explicit. Only with proper alignment, is the efficacy of instruction likely to be optimized.

Teachers interested in improving their instruction can use the Taxonomy Table (which is reproduced on the inside front cover of the revised Taxonomy) to review their plans to assure that their objectives, activities, and assessments are properly aligned. Suppose a teacher holds as an objective that students will learn to rigorously apply state rubrics to their own writing samples. He or she will need to plan the instruction so students have the opportunity to do this. The instructional activities might be organized in a way to scaffold the learning process. For example, the rubrics can be applied to pieces of writing the teacher has selected to illustrate various dimensions of the rubric. Or students can be assigned the responsibility of applying only one dimension of the rubric at a time until all of the dimensions have been understood. To the extent this is done, the activities are more likely to be aligned with the stated objective.

Furthermore, if a teacher wants to assess the extent to which students have acquired the objective, he or she will need to have ways of assessing the rigor with which students apply state rubrics to their own writing samples. When this is done, the alignment puzzle becomes complete; that is, both activities and assessments are aligned with objectives. And, as the Carroll model suggests, when instruction is aligned with the objectives, students will need to spend less time learning the objective. Thus, all things being equal, instruction will have improved.

Raising learning targets

One inference that can be derived from the Carroll model is that the learning target itself can be raised. It is on this particular point that the revised Taxonomy can be of assistance to teachers. In combination, the vignettes contain examples of the range of objectives that can be pursued in schools and classrooms. In the previously mentioned *Macbeth* vignette, Ms. Jackson had two objectives. The first was for her students to remember important details about the play, (e.g., specific events, characters, and their relationships). In contrast, the second objective was for students to understand the meaning and significance of classical literature in their own lives. It is not that remembering things is not important (see Mayer, this issue). It is that remembering things is not sufficient for being a truly educated person—a person who can use what he or she has learned previously to learn new things and to solve a variety of academic and nonacademic problems.

In this regard, the revised Taxonomy gives us two ways in which the learning target can be raised. The first is to focus on increasingly more complex cognitive processes, particularly *Analyze*, *Evaluate*, and *Create*. For example, rather than being satisfied with being able to remember or understand "tourists," "migrants," and "immigrants" as individual concepts, teachers may consider whether students should learn to

- analyze concepts such as these in a larger context (e.g., rights and obligations of nonresidents or noncitizens);
- evaluate proposals for dealing with a variety of social problems (e.g., illegal immigrants or unschooled migrants); or
- create policies that solve specific social problems without causing other problems (e.g., dealing with immigrants without negatively impacting on tourism).

A second way the learning target can be raised is to move beyond the three traditional academic types of knowledge (e.g., factual, conceptual, and procedural) and consider objectives that emphasize metacognitive knowledge (see Pintrich, this issue). One of the primary benefits of metacognitive knowledge is that it "connects" students to academic learning. That is, armed with metacognitive knowledge, students can see how academic learning relates to them and how they, in turn, relate to academic learning. Through metacognitive knowledge, they gain knowledge of strategies they can use to learn science, mathematics, foreign language, etc. They gain knowledge of subjects in which they are and are not interested.

Regardless of how this issue is addressed, one implication of the Carroll model is that as teachers are able to raise the learning target of a particular lesson or unit, it can be argued that instruction has improved.

The Paradox of Simplicity Versus Complexity in Improving Instruction

There is a sense, akin to one of Murphy's Laws, that "nothing is simple." As we prepared the revised Taxonomy, the principles that emerged concerning the importance of distinguishing objectives from activities; aligning objectives, activities, and assessments; and raising the learning target by introducing more complex objectives are all logical, simple, and supported by a good deal of common sense. At the same time, they are somewhat problematic. Our collective experiences in preparing the revised Taxonomy (especially our analysis of the vignettes) caused us to stop and reflect on enduring classroom problems and their contributions to "complexifying" these principal ideas (see Anderson, Krathwohl, et al., 2001, chap. 14). In this section I would like to discuss a few of the issues that may cause one to pause when considering the ideas presented in this article.

The conflation of activities and objectives

Many teachers, including excellent ones, often conceive of their objectives as activities students are invited to complete during an instructional unit. One purpose of a unit on the American Civil War, for example, might be "Compare the resources of the North and the South prior to the outbreak of hostilities." Is this an objective or an activity? In my earlier discussion of Ms. Airasian's unit on the Parliamentary Acts, we classified a similar objective as an activity, and advanced our belief that to use the revised Taxonomy effectively, teachers should distinguish between objectives and activities. We learned, however, that this issue is more complex than we initially believed.

The conflation, or blending, of objectives and activities can be explained in part by teachers' beliefs, based on their experiences, in the educational value of particular activities. For example, the teacher of the Civil War unit may have learned that by conducting a comparison of prewar resources of the North and South in 1860, students acquire factual knowledge about the Civil War, gain conceptual understanding of war and resources, and learn how to make comparisons in general. For this teacher, the activity statement may be a "shortcut" method of describing what is going on in class. This objective, while clear to the teacher, is implicit.

A second explanation for the conflation of objectives and activities is associated with the current push toward performance assessment (Wiggins, 1993). It is, in effect, mistaking the objective with its indicator. Teachers strive to have their students do well on a performance task. So, for example, writing an editorial, a task used to assess students' understanding, is tranformed into the lesson objective.

The conflation of objectives and activities is seen as problematic to some supervisors and evaluators who expect teachers to make distinctions between their objectives and their activities (Popham, 1973). Some teachers write very specific behavioral objectives to accommodate the expectations of their administrators. Although this approach helps clarify the distinction between objectives and activities, it also tends to narrow the richness of the activities in which students are engaged.

Assumptions about the learning target

Researchers interested in studying teaching and administrators interested in evaluating teaching like to think they are able to gauge the cognitive challenge that particular assignments offer students. My application of the Carroll model is largely based on the assumption, made sometimes by teachers and often by evaluators, that if students are addressing an objective or are engaged in a task at the high end of the revised Taxonomy, they are being cognitively challenged. However, the "push-down principle," proposed by Merrill (1971), raises questions about the validity of this assumption.

The push-down principle indicates that complex tasks become simpler and more automatic with habit. In essence, it presupposes that students addressing complex, challenging problems seek ways to reduce the complexity and minimize the challenge. Suppose, for example, a student encounters a novel problem. Initially, she selects approaches or constructs strategies until she finds one that solves it. Subsequently, when she faces a similar problem, one classified as similar in cognitive challenge to the first, the tendency is to use the same strategy or approach used the last time, thus diminishing the cognitive challenge of the problem. As Merrill (1971) pointed out, "Learners have an innate tendency to reduce the cognitive load as much as possible; consequently a learner will attempt to perform a given response at the lowest possible level" (p. 38). This is problematic for an observer watching students address a problem of apparently significant cognitive challenge who is unaware that students are actually working at lower cognitive levels. This problem is the major reason that we classify intended learning (i.e., objectives) rather than actual learning in the Taxonomy Table. Suffice it to say that as teachers attempt to improve their instruction by raising their targets, students may be working equally hard to "push down" the targets. Again, teaching is a complicated business.

Conclusion

With an eye on improving instruction, I have suggested at least two ways in which teachers might use the revised Taxonomy. The first is to properly align objectives, activities, and assessments. The second is to raise the learning targets in terms of cognitive complexity, type of knowledge (particularly metacognitive knowledge), or both. While both of these suggestions seem reasonable—almost common sense—they are not so easy to implement. Somewhat paradoxically, the conflation of objectives, activities, and assessment tasks makes it difficult to properly align objectives, activities, and assessments. In addition, the best intentions may not result in expected learning, particularly of more complex objectives. Nonetheless, the revised Taxonomy helps us understand these potential problems and begin to resolve them.

Note

1. My colleague, Frank B. Murray of the University of Delaware, first pointed out to me the potential of Carroll's formulation in this context. Of course, he is not responsible for my treatment of his original suggestion.

References

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

Carroll, J.B. (1963). A model of school learning. *Teachers College Record, 64,* 723-733.

Merrill, M.D. (1971, August). Necessary psychological conditions for defining instructional outcomes. *Educational Technology,* 34-39.

Popham, W.J. (1973). *Evaluating instruction.* Englewood Cliffs, NJ: Prentice-Hall.

Wiggins, G.P. (1993). *Assessing student performance.* San Francisco: Jossey-Bass.

Chris Ferguson

Using the Revised Taxonomy to Plan and Deliver Team-Taught, Integrated, Thematic Units

As if planning a fairly traditional subject-oriented class, taught by a single teacher, is not challenging enough, the challenge increases greatly when planning interdisciplinary units to be taught by two teachers. Based on my experience, this challenge is reduced to a large extent when both teachers understand the structure of the Taxonomy Table and use the language of the revised Taxonomy.

An Integrated Classroom

During the 2000–2001 school year, a colleague and I implemented an integrated English and history course entitled "Western Culture." The course was based on the South Carolina state standards for English II (sophomore English) and Western Civilization (a social studies elective). Our 100 sophomores (divided into three sections of about 33 students each) had their English II and Western Civilization classes scheduled in back-to-back 50-minute class periods with a short break in between. In simplest terms, then, we taught three 100-minute blocks per day.

The majority of the students in the first block were students with special needs. Consequently, a trained special needs teacher assisted in the instruction. In the other two blocks, students were grouped heterogeneously, differing widely in academic ability and motivation.

Chris Ferguson is a teacher at the Hickory Tavern Middle School in Laurens, SC.

The school we worked in was a charter school, which provided a bit more flexibility for teachers and students alike. Nonetheless, we were responsible for teaching state standards. The students in our classes were as diverse in terms of ethnicity and socioeconomic status as any other public school in our district. Approximately 28% of our students were minorities; about 10% would qualify for a gifted and talented program on the basis of their standardized test scores.

Integrating Subject Areas

My colleague and I were aware that much of what we taught in our English II and Western Civilization classes overlapped. In fact, in the past we had collaborated on short curriculum units where a single essay or research paper would count for both courses. One of the reasons for moving to a completely integrated course was to help our students become better thinkers and writers. Although we understood the role of what we referred to as content and skills in both of our courses, the connections between the two courses became clearer as we became familiar with the Taxonomy Table.

The knowledge and cognitive process dimensions enabled us to more clearly focus and explain our course integration. South Carolina's English II Standards are divided into five general areas, or strands: reading, writing, research, listening, and speaking. We took from the revised Taxonomy the

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

perception that initial learning in several of these areas—particularly writing, research, and speaking—often takes the form of applying procedural knowledge. In other words, there is a sequence of steps students must learn and use to engage successfully in basic writing, research, and speaking. Once this procedural knowledge has been mastered, students can move on to analyzing, evaluating, or even creating [based on] factual, conceptual knowledge, and even metacognitive knowledge.

South Carolina's Social Studies Standards (including those for Western Civilization) contain large amounts of factual and conceptual knowledge at the outset. In fact, remembering factual knowledge and understanding conceptual knowledge are the two most dominant categories of the South Carolina Social Studies Standards. Interestingly, therefore, when students are expected to employ more complex cognitive processes in social studies, they almost always need skills in written or oral expression.

Thus, we came to the realization that Western Civilization and English II courses are best combined when teachers are able to focus on the factual and conceptual knowledge of history and, at the same time, develop the procedural knowledge of English. Furthermore, once students have mastered the procedural knowledge of writing and speaking, they have a basis for analyzing, evaluating, and creating knowledge from both subject areas simultaneously. This, in fact, was the overall goal of our Western Culture class.

Planning the Unit: Specifying the Objectives

One of the more interesting thematic units we designed and implemented late in the school year focused on the French Revolution. Students read the Dickens novel *A Tale of Two Cities* and studied the historical content of the French Revolution. In addition to enhancing their understanding of historical fiction, students were able to use their content knowledge later to complete some assessments that were both enjoyable and cognitively challenging.

Working together, my colleague and I created separate objectives for Western Civilization and English II for the French Revolution Unit. For Western Civilization, students were expected to

- WC1. Understand and be able to explain the causes of the French Revolution;
- WC2. Remember the major characters, events, and dates related to the French Revolution; and
- WC3. Compare the three phases of the French Revolution.

For English II, students were expected to

- E1. Understand the meaning of the terms *serial writing, historical fiction,* and *novel;*
- E2. Understand literary elements (specifically, character, plot, and setting) and literary devices (e.g., foreshadowing and personification as used in Dickens' *A Tale of Two Cities*);
- E3. Use a variety of writing forms (e.g., descriptive, expository, persuasive) and structures (e.g., letters, outlines, essays) depending on the writing purpose;
- E4. Be able to make and evaluate oral presentations, according to prespecified criteria.

As we began planning the integrated unit, we placed these seven objectives in the Taxonomy Table as shown in Table 1.

The reasoning for the placement of the objectives in the Taxonomy Table is fairly obvious. Note, however, that two of the objectives were placed in multiple cells. Objective E3 requires students to understand various writing forms, structures, and purposes (conceptual knowledge), as well as write in accordance with a suggested set of teacher-given procedures (procedural knowledge). Similarly, Objective E4 involves both making and evaluating oral presentations. Making presentations is a creative act; evaluating them is, of course, an evaluative act. The reason conceptual knowledge was chosen is because the criteria (i.e., categories) were given to the students.

Planning the Unit: Determining the Instructional Activities

Over the course of the school year, my colleague and I discovered that because projects actively involve students, they are the most effective way of maximizing student participation and learning. However, traditional teaching methods—such as lecture, discussions, and textbook assignments—

Table 1
An Analysis of the Unit Objectives in Terms of the Taxonomy Table

	The Cognitive Process Dimension					
The Knowledge Dimension	1. ***Remember***	2. ***Understand***	3. ***Apply***	4. ***Analyze***	5. ***Evaluate***	6. ***Create***
A. ***Factual Knowledge***	WC2					
B. ***Conceptual Knowledge***		WC1 WC3 E1 E2 E3			E4	E4
C. ***Procedural Knowledge***						
D. ***Metacognitive Knowledge***						

Key
WC1. Understand and be able to explain the causes of the French Revolution.
WC2. Remember the major characters, events, and dates related to the French Revolution.
WC3. Compare the three phases of the French Revolution.
E1. Understand the meaning of the terms *serial writing, historical fiction,* and *novel.*
E2. Understand literary elements (specifically, character, plot, and setting) and literary devices (e.g., foreshadowing and personification).
E3. Use a variety of writing forms (e.g., descriptive, expository, and persuasive) and structures (e.g., letters, outlines, or essays) depending on writing purpose.
E4. Be able to make and evaluate oral presentations, in accordance with prespecified criteria.

are necessary to introduce students to the factual and conceptual knowledge they'll need to complete the projects. Specifically, this factual and conceptual knowledge enables students to work together and use more complex cognitive processes while working on their projects. Therefore, the initial instructional activities for the first eight days of this unit resembled a traditional classroom setting, including very familiar forms of instruction.

Days 1–8

During his initial lecture, Mr. Gillespie, the English instructor, reviewed the concepts that would be used by students throughout their reading of *A Tale of Two Cities* (Objectives E1 and E2). During this period, large blocks of time were devoted to reading both the novel and the chapter in the history text on the French Revolution. To facilitate reading the novel, Mr. Gillespie divided it into sections, as if students were "watching" an old-fashioned serial. After each installment, students, working in groups of three, were responsible for summarizing the plot of *A Tale of Two Cities*, identifying new characters or settings, and continuing to develop familiar characters and settings. As they read the corresponding chapter in the history textbook, students were expected to take notes about characters, events, and dates (Objective WC2). The discussions in the textbook focused on the causes and phases of the French Revolution (Objectives WC1 and WC3).

By the end of the eighth day, students were expected to have completed reading the novel and the textbook chapter, and written a complex set of notes.

Days 9–14

Students, working in groups of four, were assigned a historical or fictional character to prosecute or defend in a trial, and were given an assignment sheet to guide them through the project (see Figure 1). Because the class would also serve as the jury, students designed rating scales to determine,

Figure 1

French Revolution/Charles Dickens Trial Assignment Sheet

Introduction: Trials were a major part of both the French Revolution and the novel *A Tale of Two Cities.* In this project, you and your group members will assume the role of prosecutors and defenders of major characters, both historical and fictional.

Goal: The goal of the project is for you to apply the knowledge you have learned to either convict or liberate your character. You may attempt to manipulate the information to benefit your cause, but you must stick closely to the facts you have seen or read. Lying, or perjury, will not be tolerated and will drastically harm your grade.

Here is the process we will use:

1. Divide into groups of four. Characters will be randomly assigned to two opposing groups. There will be no changing of groups once the characters have been assigned. The possible characters and the charges against them are as follows:

Louis XVI – Treason	Marquis St. Evremonde - Murder
Marie Antoinette – Treason	M. and Md. Defarge - Murder
Robespierre – Treason/Murder	Miss Prosser - Murder

2. Working with your group, you will choose witnesses to call, items of evidence to introduce, and strategies to convict or defend. You must convince a jury consisting of all of your classmates that your client is either guilty or innocent. Mr. Gillespie and Mr. Ferguson will act as the judges for alternate cases, and we will determine if testimony, evidence, and arguments are consistent with the facts.

3. A witness list will be turned in one week prior to the trial. Witnesses that appear on both lists will be role-played by either Mr. Gillespie or Mr. Ferguson. We will attempt to remain neutral during questioning by both sides.

4. Witnesses that appear on only one side's list will be role-played by a person from your group. Again, the judge will determine if testimony is acceptable or not. Feel free to object to the other group's questions, but do so in an organized manner.

5. The class will develop some guidelines for determining the outcome of the trial based on the proof presented. These guidelines will help ensure neutrality by the jury.

Good luck! Be creative, but be ethical!

based on the evidence presented during the trial, which side had won its case. A conglomeration of the rating scales created by students in all three classes is shown in Figure 2. Preparation for the trials took place on Days 9–11; the trials took place on Days 12–14.

Day 15

An important step in all integrated units is to allow students to summarize their knowledge in some type of writing. For this unit, we asked students to write a response to the following prompt: "Former Communist Chinese leader Mao Tse Tung wrote, 'The greater the suppression, the greater the revolution.' Is this true for the French Revolution? On what do you base your answer?" Essays of this sort often prove to be the most interesting aspect of the unit because they provide insight into how students have integrated new information into their existing schemas. They also enable us to determine the effects of this new knowledge on students' outlook on life—what we believe is the most exciting aspect of teaching!

Planning the Unit: Assessments

The authors of the revised Taxonomy clearly differentiated between formative and summative assessments, and we believe that this is a critically

Figure 2
Burden of Proof–Prosecution

1. Did the prosecution present evidence that was consistent or at least plausible?

YES________________________________NO
5 4 3 2 1

2. Were the prosecution's witnesses believable?

YES________________________________NO
5 4 3 2 1

3. Were the prosecution's closing arguments more effective than the defense's?

YES________________________________NO
5 4 3 2 1

4. Did the prosecution prove the charges beyond a reasonable doubt?

YES________________________________NO
5 4 3 2 1

5. Which side do you believe best proved their case?

PROSECUTION____________________DEFENSE
5 4 3 2 1

Why? Briefly explain your rating.

important distinction. Formative assessment is "gathering information about learning as learning is taking place, so that 'in-flight' instructional modifications may be made to improve the quality or amount of learning" (Anderson, Krathwohl, et al., 2001, pp. 101-102). In summative assessment, on the other hand, we "gather information about learning after learning should have occurred, usually for the purpose of assigning grades to students" (p. 102).

As mentioned earlier, we believe students need a solid foundation of factual and conceptual knowledge before beginning work on projects. Therefore, our focus early in the unit was on formative assessments (see Figure 3 for an example). We used information gained from these assessments to adjust our instruction to focus on those areas in which students were experiencing difficulties.

We rely heavily on the projects themselves as summative assessments. This is appropriate since projects require students to apply, analyze, evaluate, and create based on the knowledge they have gained previously, as well as the knowledge they gain while doing the research for the projects themselves. By combining formative with summative assessment, then, we are able to address all six categories of the Taxonomy Table.

One indirect outcome of this assessment pattern is that we have completely shifted our outlook on why we ask students to complete certain tasks. Similarly, and perhaps more importantly, students come to view assessment as a more personalized event, rather than an attempt to compare them with other students. They also seem to enjoy assignments where they are asked to create a product, and appreciate the personalized feedback they receive from us as teachers.

Finally, we took great care in ensuring that our assessments were aligned with our objectives. In the sample assessment in Figure 3, for example, students are asked to determine whether given titles were serials, historical fiction, or neither. This assessment was aligned with the first Objective E1 (see Table 1).

Another example of formative assessment is having students write a business letter to King Louis XVI from the perspective of a member of the Third Estate in France prior to the Revolution. Students should identify themselves and their occupation, and describe their living conditions. Finally, they should ask the King for some relief, citing examples from the French Enlightenment philosophers to suggest changes that Louis could make to prevent violence. This assessment is aligned with two objectives: WC1 and E3.

Two of the summative assessments were a matching quiz on factual knowledge (WC2) and a written outline describing the three changes in government during the French Revolution (WC3 and E3). As mentioned earlier, however, the mock trials are the major summative assessment, and constitute 60% of a student's grade. These trials, primarily targeted toward Objective E4, involved several of the other objectives as well as several of the cells of the Taxonomy Table not specified as objectives (e.g., analyze, metacognitive knowledge). Serving as members of the jury, the class must evaluate [based on] factual, conceptual, and procedural knowledge. And those students who are witnesses must create a persona based on factual knowledge. This assessment, then, is truly summative in the

Figure 3

Serials, Historical Fiction, and Novel Worksheet

Using the definition of a serial (or series), indicate whether each of the following items is an example of a serial by writing **yes** or **no** in the blank next to it.

______ Superman comic book	______ *Reader's Digest*
______ *Survivor*	______ *Vogue*
______ *A Tale of Two Cities*	______ *Star Wars*
______ *Titanic*	______ *Days of Our Lives*

List any two serials you have seen or read.

____

____

Using the definition of historical fiction, indicate whether each of the following items is an example of historical fiction by writing **yes** or **no** in the blank next to it.

______ *Titanic*	______ *Autobiography of Malcolm X*
______ *The Patriot*	______ *A Tale of Two Cities*
______ *Julius Caesar* by Shakespeare	______ *Forrest Gump*
______ *The Hunt for Red October*	______ *JFK*

List one example of historical fiction you have seen or read. Also, give one example of a work you have seen or read that is either nonfiction or pure fiction.

____

____

On a separate sheet of paper, write an answer to the following question:

Using what you know about the novel as a form of entertainment, social commentary, self-expression, and a financial undertaking, discuss the role of modern movies as novels. Are movies better than novels? Why?

sense that it "sums up" student learning in a comprehensive, integrative way.

Conclusion

The Taxonomy Table has helped us develop our integrated, thematic course in three very specific ways. First, it has given us a common language with which to translate and discuss state standards from two different subject areas. Second, it has helped us understand how our subjects overlap and how we can develop conceptual and procedural knowledge concurrently. Third, the Taxonomy Table has given us a new outlook on assessment and has allowed us to create assignments and projects that require students to operate at more complex levels of thinking. These benefits alone have helped us develop a course that is enjoyable and challenging for our students and ourselves.

References

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

P. Ann Byrd

The Revised Taxonomy and Prospective Teachers

OVER THE NEXT TEN YEARS, an additional 2.2 million teachers will be needed in the United States. Increases in student enrollment, reductions in class sizes at the primary grades, implementation of full-day kindergarten programs, and increases in the requirements for high school graduation are just some of the contributing factors to the tremendous teacher shortage. In South Carolina, even though the number of teachers has increased by 30% since the 1980s, the state's teacher education programs will produce only about three-fourths of the teachers that will be needed during the next decade (South Carolina Center for Teacher Recruitment, 1998).

With the national and state statistics in mind, South Carolina has proactively addressed teacher recruitment challenges by targeting precollegiate audiences as part of an ongoing campaign to promote teaching as an attractive option for academically talented high school students. By offering a survey education course called Teacher Cadet, approximately 75% of the high schools in South Carolina provide these students with opportunities to explore the role of the teacher and the importance of education—to themselves and to society.

The Teacher Cadet Program (TCP) is an innovative teacher recruitment strategy that provides high school students with a challenging introduction to the teaching profession. Participation in TCP gives high school students insights into the nature of teaching, the problems of schooling, and the critical issues affecting the quality of education in America's schools. The primary goal of TCP is to encourage academically talented or capable students who possess exemplary interpersonal and leadership skills to consider teaching as a career. An important secondary goal is to provide those who choose not to enter the teaching profession with sufficient understanding about teaching and schools so they will be civic advocates of education, regardless of what occupation or profession they enter.

P. Ann Byrd is the executive director of the South Carolina Center for Teacher Recruitment.

A Brief Introduction to the Teacher Cadet Program

Piloted in four South Carolina high schools in 1985-1986, the TCP has grown to include approximately 150 of the 200 high schools in the state. Currently, TCP enrolls approximately 2,500 high school juniors and seniors each year. To be eligible for TCP, students must maintain at least a 3.0 average (on a 4.0 scale) in a college preparatory curriculum, receive written recommendations from five teachers, and submit an essay giving their reasons for wishing to participate in the class.

TCP instructors serve as facilitators of learning, rather than the traditionally stereotypical "fountains of knowledge." Their role is to raise questions and engage in a meaningful dialogue with their

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

students about possible answers to these questions. The Cadets, as they are called, are viewed as active participants in the learning process, capable of constructing their own knowledge. The curriculum provides a balance of information and opportunities for discovery. The use of technology, opportunities for problem solving, and student interactivity are key elements in making the curriculum appealing to both students and teachers.

The curriculum for TCP, *Experiencing Education*, is divided into three major sections: *The Learner*, *The School*, and *The Teacher and Teaching*. The text is designed to introduce students to the field of education. The first unit, *The Learner*, helps students become better acquainted with themselves as individuals, learners, and community members. The second unit, *The School*, helps students develop a greater understanding of the history of education in South Carolina and in the nation, as well as insights into the structure and functions of American schools and school systems. The third unit, *The Teacher and Teaching*, is designed to acquaint students with the art and science of teaching, as well as focus the attention of students on the teacher as both a person and a professional. After having studied themselves and others as learners in Section I, and examining the history, organization, and personnel of the school in Section II, students engage in the observation, analysis, and, ultimately, the practice of classroom teaching while working through Section III.

The primary purpose of this article is to illustrate how TCP teachers can use the revised Taxonomy to plan the units included in Section III, and also how the revised Taxonomy enables the Cadets to acquire a conceptual framework they can use to better understand teachers and teaching. Furthermore, because the major objective of Section III is for students to examine the art and science of teaching as a profession—from both sides of the desk—the language of the revised Taxonomy can facilitate communication between teachers and students.

Section III contains the following five units, each of which is defined by explicit objectives and sets of connected activities:

Unit 1 – The Teacher
Unit 2 – The Process of Teaching
Unit 3 – Methods of Teaching
Unit 4 – SAY (Science and Youth), MAY (Math and Youth), and FLAY (Foreign Language and Youth)
Unit 5 – The Real Thing

After completing an initial series of focused observations in early childhood, elementary, middle, and high school classrooms, students study what is known about teachers and teaching. The culminating activity for this section, which occurs in Unit 5, is for students to serve as teacher interns in a classroom for at least three weeks. While doing so, students analyze their own work, their cooperating teacher's work, and the work of their students to enhance and reinforce the knowledge and skills gained throughout the TCP course.

Using the Revised Taxonomy to Examine Unit 3

To illustrate the use of the revised Taxonomy, objectives for Unit 3, Methods of Teaching, will be used. According to the standard curriculum, Unit 3 contains a single goal and a single terminal objective. The goal states that "students will become familiar with the various methods to deliver lessons creatively and effectively." The terminal objective, which in the context of the revised Taxonomy is actually an activity (see Raths, this issue), states that "students will produce a log documenting the various teaching methods they observe used in their different classes throughout a period of one week." Immediately, we have the opportunity to discuss the key differences between objectives and activities. Note that this discussion can be approached from either the teacher's or student's point of view.

From the teacher's perspective, the fundamental question is "What are students *expected to learn* by producing a log documenting the various teaching methods they observed during the week?" From the student's perspective, the fundamental question is "What *did you learn* by producing a log documenting the various teaching methods you observed during the week?" In addition to focusing on the distinction between objectives and activities, this discussion also leads to a realization on both parts that expectations do not always become realities.

The curriculum guide for the course includes suggested activities, rationales for the various activities, student and/or instructor handouts, and assessment options. Because the Teacher Cadet course is what has traditionally been called a "survey" course, the instructor has the option of choosing the particular activities and assessments he or she will use. Unit 3 takes place during the third quarter of the course, so the instructor is often able to explore most, if not all, of the 11 suggested activities within a three-week period. Each activity requires approximately one or two days to complete, depending on the depth of discussion that follows each activity. Due to space limitations, it is impossible to describe and consider all 11 activities in this paper. Two activities, "An Overview of Methodology" (which is the introductory activity for the unit) and "It's a Matter of Style," will be used to illustrate the points to be made.

An Overview of Methodology

The teacher begins by writing on the board: "Teaching methods: What works?" Students are asked to think about and then "discuss" this question with one another. However, students are told they must remain silent during the "discussion." They may go to the board to write their responses, but they cannot communicate orally with anyone. If they wish to respond to another student's comments, they can do so physically (for example, by shaking their heads) or by returning to the board to write their reaction.

Once all students have had the opportunity to express their views, the teacher calls on several students to read aloud the comment from the board that they find most meaningful to them and explain why they chose that comment. This typically leads to a "real" discussion of teaching methods. The teacher concludes the discussion by explaining that, during this unit, they will be studying several frequently used teaching methods.

In terms of the revised Taxonomy, this activity can serve several functions. As an overview, it can serve a motivational function. If this is the case, we are dealing with the *Metacognitive Knowledge* cells of the Taxonomy Table. Or it can serve to illustrate the importance of verbalization in communication, an important principle. In that case, we may be dealing with the *Conceptual Knowledge* cells of the Taxonomy Table. The activity could also serve to illustrate the importance of using written rather than oral communication in the classroom to provide equal opportunity for all students and minimize the likelihood of one or two students dominating the discussion. Once again, we are likely dealing with *Conceptual Knowledge.*

The "correct" placement of the activity in the Taxonomy Table is not the issue here; the issue is the purpose for which the activity was chosen by the teacher (i.e., the activity-objective connection). Rather than having an activity for activity's sake, the revised Taxonomy makes it clear that activities are selected primarily for their effect on student learning.

In terms of assessment, students are asked to generate a list of pros and cons about "Silent Graffiti" as a teaching methodology, and list examples of ways this technique might be used in other classes. In terms of the Taxonomy Table, the focus of this assessment is on analyzing metacognitive knowledge (i.e., what each individual student believes the pros and cons to be in some larger context), and applying procedural knowledge (particularly item Cc within the *Knowledge Dimension,* "knowledge of criteria for determining when to use appropriate procedures").

It's a Matter of Style

The teacher opens the lesson by announcing to students that some changes are going to be made in the classroom to enhance their learning. The teacher explains that two possible changes are being considered and that he or she would like the students' input before making the decision. Using an overhead, the teacher presents the two possible scenarios.

In Classroom 1, soft music will be playing continuously while students are working. Harsh fluorescent lighting will be replaced with softer, lower lighting. The room will be kept at a comfortable, cool temperature throughout the school year. The room will be carpeted. Desks will be replaced with enough sofas and comfortable easy chairs and rocking chairs around the room to accommodate everyone. Laptop desk pads can be used for students to work on. Time will be allowed throughout the day for students to work on several projects at a time, alone or in groups. Students will be permitted to take breaks as the need arises. Chewing gum, sodas, and snacks will also be permitted while students are studying.

In contrast, Classroom 2 will be a quiet zone in which noise will be kept to a minimum in order to allow students to study. Full use will be made of natural light, bright outdoor style lighting with skylights and recessed lighting over study areas. Passive radiant heat will keep the room comfortably warm. New desks and individual study cubicles will be placed in the room. Desks will be arranged in the central portion of the room with a study cubicle placed around the perimeter of the room. A schedule will be set up to allow students uninterrupted study time for each subject. A break will be scheduled after study time. Snacks will be permitted during break time.

Students are then asked to select the classroom option they consider to be the best and to give reasons for their choices. Next, the teacher poses the question of what types of learners may do better in the two classrooms. The teacher guides the discussion to ensure that issues pertaining to the analytical (left-brained) learners (Classroom 2 scenario) and the global (right-brained) learners (Classroom 1 scenario) are considered. To facilitate this discussion, the teacher distributes copies of the characteristics of global and analytic learners. Following the discussion, the teacher reminds students that they will encounter both types of students in an ordinary classroom, and asks them to describe in writing how they can design a classroom that accommodates the needs and preferences of both types of students.

Like the Overview of Methodology activity, this activity reinforces the need to connect activities to objectives. When this is done, we see that the emphasis is on understanding conceptual knowledge (e.g., types of classrooms, types of students) first, but later shifts to creating [based on] factual, conceptual, and, perhaps, procedural knowledge.

In terms of assessment, students work in small, mixed groups of global and analytical learners *to create* an ideal classroom and mini lesson plan for operating within that classroom. Both the classroom organization and lesson plan must address the learning needs of all students, whether they be analytical or global. The descriptions of the ideal classroom and mini lesson plan are evaluated by their classmates and the teacher based on a predetermined set of criteria that relate to previous studies of effective classroom cultures and lessons. Students are assessed on their ability to create an ideal classroom and lesson plans as defined by the criteria established.

In terms of the Taxonomy Table, the initial reaction is that we are dealing with *Create* as the primary cognitive process. However, it is not the process but the result or outcome of that process that is being assessed and evaluated. Consequently, the assessment emphasis is on *Understanding Conceptual Knowledge,* where the relevant conceptual knowledge is defined by the evaluation criteria.

Conclusion

The use of the revised Taxonomy, particularly the Taxonomy Table, can assist both teachers and students in Teacher Cadet Programs. Perhaps its greatest value is in its ability to give teachers and students something to reflect on. For years we have heard about the value of reflection as part of effective teaching. Quite clearly, reflection is a process. The issue becomes, "About what should teachers reflect?" The revised Taxonomy provides one answer to this question. Teachers should reflect on the fundamental questions that have plagued them for some time (see Anderson, Krathwohl, et al., 2001, chap. 14). Within this larger context, teachers who engage in reflection (given sufficient time and opportunity to do so) will gain a deeper understanding of what is truly known about classroom practice and, ultimately, what they can do to improve classroom practice.

The rather unique setting in which Teacher Cadet instructors work includes their being able to reflect on their classroom practice while working with potential preservice students who are also engaged in thinking about classroom practice. When one considers that the activities included in the TCP curriculum are much too numerous to be covered in their entirety, the revised Taxonomy provides a framework for determining what should and, perhaps, must be addressed if the desired cognitive processes and types of knowledge are to be acquired or constructed. Because the course is taught in approximately 150 of the 200 high schools in South Carolina by teachers with varying degrees of knowledge and expertise, this reflection and self-awareness (within the context of the revised Taxonomy) has great potential to produce a desired consistency across sites.

In addition, the Taxonomy Table provides a framework within which TCP teachers can model not only the way they teach but also the way they examine and analyze their teaching. In this regard, Cadets should learn that they can only judge the effectiveness of their teaching in terms of what students actually learn. Simply stated, the revised Taxonomy moves prospective teachers away from a "best practice" approach to teaching.

Ultimately, applying the revised Taxonomy to the objectives of the TCP curriculum will be useful in revising the curriculum to more specifically address the overall purpose of the course and the present and future needs of those who enroll in it. For curricular alignment, examining the core standards, instructional activities, and assessments of the course in terms of the revised Taxonomy provides yet another lens through which to examine the effectiveness of the course content in its ultimate goal to attract high schools students to enter the teaching profession.

References

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

South Carolina Center for Teacher Recruitment. (1998a). *Experiencing education: Teacher cadets.* Rock Hill, SC: Author.

South Carolina Center for Teacher Recruitment. (1998b). *Strengthening the profession that shapes South Carolina's future–Teaching.* Rock Hill, SC: Author.

South Carolina Center for Teacher Recruitment. (2001). *SCCTR Annual Report 2000–2001.* Rock Hill, SC: Author.

Peter W. Airasian
Helena Miranda

The Role of Assessment in the Revised Taxonomy

As mentioned previously, one of the major differences between the original Taxonomy and the revised Taxonomy is that the original Taxonomy consisted of a single dimension; the revised Taxonomy reflects a dual perspective on learning and cognition. Having two dimensions to guide the processes of stating objectives and planning and guiding instruction leads to sharper, more clearly defined assessments and a stronger connection of assessment to both objectives and instruction. The power of assessments, regardless of whether they take the form of a classroom quiz, a standardized test, or a statewide assessment battery, resides in their close connection to objectives and instruction. The Taxonomy Table is a useful tool for carefully examining and ultimately improving this connection.

Assessment Implications of the Revised Taxonomy

Regarding assessment, the two-dimensional Taxonomy Table emphasizes the need for assessment practices to extend beyond discrete bits of knowledge and individual cognitive processes to focus on more complex aspects of learning and thinking. It also provides a way to better understand a broad array of assessment models and applications. Finally, the Taxonomy Table reinforces the perspective of the authors of the original Taxonomy that different types of objectives require different types of assessment, whereas similar types of objectives (regardless of subject matter) require similar approaches to assessment.

The Cognitive Process dimension calls our attention to the need to find ways of validly and reliably assessing so-called "higher-order" processes. One of the purposes of the original Taxonomy was to illustrate how multiple-choice test items could be used to test various taxonomic levels. Are these tests still useful in this regard, or are new assessment techniques needed? The Knowledge dimension emphasizes the need to find ways of validly and reliably assessing metacognitive knowledge. Knowledge of cognitive strategies, cognitive tasks, and self not only requires different ways of thinking about assessment, but, in the latter case, reintroduces the need to engage in affective assessment. The need to assess higher-order cognitive processes and metacognitive knowledge poses challenges for all who are engaged in the assessment field.

It is generally understood, but it bears repeating, that the information obtained during the assessment process is influenced to a great extent by what has preceded it during the instructional process, particularly as both processes (instruction and assessment) are aligned with the stated objective. If

Peter W. Airasian is a professor of education and Helena Miranda is a graduate assistant, both at Boston College.

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

the three components are well aligned, the assessment results are likely to be reasonably valid. Conversely, if the three components are not well aligned, the assessment results will be of questionable validity.

Consider an educational objective frequently given by English teachers: "Students will learn to state the main idea of a short story." In this objective, the critical verb is "state" and the noun phrase is "main idea of a short story." But there are multiple ways students can learn to state a main idea. For example, students can state the main idea by remembering what the teacher has told them about the story's main idea during instruction (e.g., "This is the main idea of short story A."). Students can also state the main idea based on inferences they make from key information provided in the short story. In this case, students learn by understanding (since *inferring* lies within *Understand* in the Taxonomy Table). Alternatively, students can state a story's main idea by following a set of steps the teacher has taught them to help find main ideas, or *applying procedural knowledge.* Finally, students can state the main idea by differentiating key points from supporting details. In this case, because *differentiating* lies within *Analyze* in the Taxonomy Table, students would learn by analyzing. In a classroom or statewide assessment, then, test items or assessment tasks for the objective "Students will learn to state the main idea of a short story" could focus on remembering factual knowledge, understanding, applying procedural knowledge, or analyzing.

To avoid this confusion, we have suggested that the 19 cognitive processes identified in the revised Taxonomy (or, alternatively, the six process categories) should be used as the verbs when stating objectives. Ambiguous verbs such as "state," "list," "demonstrate," and so on, should be used with great care because many of these terms are more applicable to assessment than to learning. For example, students can *demonstrate* that they have remembered what they should have remembered. At the other end of the spectrum, they can *demonstrate* the results of an extremely creative process. In between, they can *demonstrate* their ability to understand, apply, analyze, and evaluate.

Another benefit of the revised Taxonomy is to focus on methods of assessment linked with particular types of objectives. Consider, for example, the following three objectives:

- Students can remember addition facts totaling 40.
- Students can recall definitions of social studies terms.
- Students can recall important dates in the Civil War.

Each of these objectives focuses on a different subject area: mathematics, social studies, and history. Yet, because all three objectives are examples of remembering factual knowledge, the appropriate test items or assessment tasks will all be quite similar. For example:

- List all pairs of whole numbers that sum to 40.
- List the social studies terms that match the following definitions.
- List the dates on which the following events in the Civil War took place.

Thus, objectives as varied as remembering the alphabet, remembering the names for parts of a cell, remembering the location of cities on a map, remembering key facts about various countries, and other "remember factual knowledge" objectives will typically be assessed by asking students to "state," "list," "label," or "name" the relevant factual knowledge.

There are similar generalized assessment formats and approaches for understanding conceptual knowledge and applying procedural knowledge. We know from the revised Taxonomy that conceptual knowledge includes categories, principles, and models. One way to determine if students understand a particular category, for example, is to have them determine whether a particular instance or example falls within the category. In the revised Taxonomy, this cognitive process would be termed *classifying,* which lies within *Understand.* It is important to note that this approach to assessment is applicable regardless of the specific category included in the objective (e.g., rational numbers, sonnets, arachnids, civil law, or impressionist paintings). One possible assessment format for all of these would be: "Here is an example. Is this an example of X?" where X could be replaced by a rational number, sonnet, and so on.

Using the Taxonomy Table to Examine Assessment

In order to critically examine and refine the revised Taxonomy, we asked six teachers, working at a variety of grade levels, to describe actual instructional units they had taught in their main subject area. A great deal of information about the teachers' units and the usefulness of the revised Taxonomy, particularly the Taxonomy Table, derived from our examination of these written vignettes. In particular, the use of the Taxonomy Table on the teachers' vignettes provides useful information about the validity of classroom and statewide assessments as evidenced by the alignment of the assessments with both objectives and instructional activities.

We illustrate this feature of the Taxonomy Table by analyzing the Parliamentary Acts vignette in terms of the stated objectives, the instructional activities, and the assessments. Figure 1 summarizes the placement of the teacher's four stated objectives in the Taxonomy Table. Note that one of the objectives is placed in two cells of the Taxonomy Table. This objective states that students should be able to choose a colonial character or group and write a persuasive editorial stating his/her/its position. Writing such an editorial is a creative process that requires two types of knowledge: factual knowledge (e.g., specific details about various colonial characters) and conceptual knowledge (e.g., criteria that define good persuasive writing). Brief statements of all four objectives are included at the bottom of Figure 1.

Subsequent to identifying the intended objectives, the teacher turned her attention to instruction. The planned instructional activities required 10 days to complete. Since instructional activities are not the primary focus of this article, they are simply listed in terms of the sequence and number of days for sets of activities. These are shown in Figure 2. To examine the connection between the activities and objectives, the objectives shown in Figure 1 are repeated in Figure 2.

In most cases, the instructional activities are closely aligned with the objectives. Specifically, there are instructional activities related to each of the four objectives (cells A1, A6, B2, B5, and B6). There are two cells of the table (B4 and C3) that have instructional activities but no stated objectives.

The final piece of the vignette concerns the assessments. The placement of the assessments used by the teacher in terms of the Taxonomy Table is shown in Figure 3. The placement of both the objectives and instructional activities in the Taxonomy Table as shown in Figure 1 and Figure 2 are reproduced in Figure 3.

As the key at the bottom of Figure 3 indicates, the teacher used three assessments: classroom questions and informal observations (Assessment A), a quiz (Assessment B), and a performance assessment (namely, the writing of a persuasive editorial) (Assessment C). As shown in the figure, the quiz was intended to assess student mastery of the first objective ("Remember specific parts of the Parliamentary Acts"). Classroom questions and informal observations were intended to assess student mastery of the second objective ("Explain the consequences of the Parliamentary Acts for different colonial groups"). And, the performance assessment was intended to assess student mastery of the third objective ("Choose a colonial character or group and write a persuasive editorial stating his/her/its position").

The completed Taxonomy Table shown in Figure 3 indicates strong alignment of assessment, objectives, and instruction in the unit, particularly evidenced in cells A1, A6, B2, and B6. It is noteworthy that the performance assessment is in multiple cells because 10 criteria are involved in evaluating the editorial. One or more of the criteria are placed in A6, one or more in B6, and one or more in C3.

In light of this high degree of alignment, two of the other cells, C3 and B5, are worthy of comment. In Cell C3, we have some activities and one or more criteria related to the persuasive essay, but we do not have an explicitly stated objective. In B5, on the other hand, we have an explicitly stated objective and several days of activities, but we do not have any direct assessment. Finally, we could envision a cell in which we have an explicitly stated objective and a direct assessment, but no instructional activities. These three cells indicate three types of misalignment involving assessment. Cell C3 illustrates what has been termed "instructional sensitivity" (i.e., the assessment is "sensitive" to instruction) (Haladyna & Roid, 1981). Cell

The Knowledge Dimension	The Cognitive Process Dimension 1. *Remember*	2. *Understand*	3. *Apply*	4. *Analyze*	5. *Evaluate*	6. *Create*
A. ***Factual Knowledge***	**Objective 1**					**Objective 3**
B. ***Conceptual Knowledge***		**Objective 2**			**Objective 4**	**Objective 3**
C. ***Procedural Knowledge***						
D. ***Metacognitive Knowledge***						

Key
Objective 1: Remember the specific parts of the Parliamentary Acts.
Objective 2: Explain the consequences of the Parliamentary Acts for different colonial groups.
Objective 3: Choose a colonial character or group and write a persuasive editorial stating his/her/its position on the Acts.
Objective 4: Self- and peer edit the editorial.

Figure 1. An analysis of the Parliamentary Acts vignette based on stated objectives.

The Knowledge Dimension	The Cognitive Process Dimension 1. *Remember*	2. *Understand*	3. *Apply*	4. *Analyze*	5. *Evaluate*	6. *Create*
A. ***Factual Knowledge***	**Objective 1** Days 2, 3, & 5 Activities					**Objective 3** Days 8-10 Activities
B. ***Conceptual Knowledge***		**Objective 2** Days 1, 4-7 Activities		Days 6-7 Activities	**Objective 4** Days 8-10 Activities	**Objective 3** Days 8-10 Activities
C. ***Procedural Knowledge***			Day 4 Activities			
D. ***Metacognitive Knowledge***						

Key
Objective 1: Remember the specific parts of the Parliamentary Acts.
Objective 2: Explain the consequences of the Parliamentary Acts for different colonial groups.
Objective 3: Choose a colonial character or group and write a persuasive editorial stating his/her/its position on the Acts.
Objective 4: Self- and peer edit the editorial.

Figure 2. An analysis of the Parliamentary Acts vignette based on stated objectives and instructional activites.

The Cognitive Process Dimension

The Knowledge Dimension	1. ***Remember***	2. ***Understand***	3. ***Apply***	4. ***Analyze***	5. ***Evaluate***	6. ***Create***
A. ***Factual Knowledge***	**Objective 1** Days 2, 3, & 5 Activities *Assessment B*					**Objective 3** Days 8-10 Activities *Assessment C*
B. ***Conceptual Knowledge***		**Objective 2** Days 1, 4-7 Activities *Assessment A*		Days 6-7 Activities	**Objective 4** Days 8-10 Activities	**Objective 3** Days 8-10 Activities *Assessment C*
C. ***Procedural Knowledge***			Day 4 Activities *Assess-ment C*			
D. ***Metacognitive Knowledge***						

Key

Objective 1: Remember the specific parts of the Parliamentary Acts.
Objective 2: Explain the consequences of the Parliamentary Acts for different colonial groups.
Objective 3: Choose a colonial character or group and write a persuasive editorial stating his/her/its position on the Acts.
Objective 4: Self- and peer edit the editorial.
Assessment A: Classroom Questions and Informal Observations
Assessment B: Quiz
Assessment C: Performance Assessment (editorial, with 10 evaluation criteria)

Figure 3. An analysis of the Parliamentary Acts vignette based on stated objectives, instructional activites, and assessments.

B5 illustrates what might be termed "assessment-free" curriculum and instruction. The "envisioned cell" illustrates the traditional concept of "content validity," where concerns for students' opportunities to learn the content are minimal.

Conclusion

Severe misalignment of assessment, objectives, and instruction can cause numerous difficulties. If, for example, instruction is not aligned with assessment, even the highest quality instruction will likely not lead to high student performance on the assessments. As mentioned previously, by focusing on the Taxonomy Table we can increase the alignment of assessment with both objectives and instruction.

In addition to its use in classroom instruction and assessment, the Taxonomy Table can also be used to analyze the results of statewide assessments in terms of their possible and likely impact on curriculum and instruction. Increasingly, teachers and their students are confronted with statewide standards and corresponding statewide assessments. These high-stakes assessments have become consequential for both students and teachers. Using the Taxonomy Table to increase the alignment of school-wide or district-wide curriculum and instruction with state standards and state-mandated assessments will enable teachers to focus on the standards without "teaching to the test."

Because the Taxonomy Table focuses on student learning rather than student performance, it emphasizes the need to focus on the cognitive processes and types of knowledge required to achieve the standards, rather than the specific or general types of items included on the statewide assessments. Once determined, this knowledge of relevant cognitive processes and types of knowledge (a kind of educator metacognitive knowledge) can be used to make necessary adjustments in curriculum and instruction that are needed to improve the effectiveness of the entire educational system.

Reference

Haladyna, T. & Roid, G. (1981). The role of instructional sensitivity in the empirical review of criterion-referenced test items. *Journal of Educational Measurement, 18*, 39-53.

Lorin W. Anderson

Curricular Alignment: A Re-Examination

THERE *IS* A STORY that needs to be told. . . . It is a story about children and also about curricula—curricula transforming national visions and aims into intentions that shape children's opportunities for learning through schooling. (Schmidt & McKnight, 1995, p. 346)

We must "[change] the question from 'What students know and can do' to 'What students know and can do as a result of their educational experiences.'" (Burstein & Winters, 1994)

During the past half-century there has been a growing body of evidence supporting a fundamental educational truism: that *what* and *how much* students are taught is associated with, and likely influences, *what* and *how much* they learn. In fact, the results of several fairly recent studies suggest that, in terms of measured student achievement, *what* students are taught is more important than *how* they are taught (Alton-Lee & Nuthall, 1992; Breitsprecher, 1991; Gamoran, Porter, Smithson, & White, 1997). Over time, different terminology has been used to denote the "what" of teaching. The three terms that have generated the most research interest are "content coverage," "opportunity to learn," and "curriculum alignment." Importantly, these are not just different labels for the same basic idea; there are important conceptual distinctions underlying them. These distinctions can be understood by examining Figure 1.

Lorin W. Anderson is a professor of education at the University of South Carolina.

Content Coverage, Opportunity to Learn, and Curriculum Alignment

Figure 1 contains three primary components of curriculum: objectives (also known in today's vocabulary as content standards or curriculum standards), instructional activities and supporting materials, and assessments (including standardized tests). The sides of the triangle represent relationships between pairs of components: objectives with assessments (side A), objectives with instructional activities and materials (side B), and assessments with instructional activities and materials (side C).

Traditionally, the issue of the relationship between objectives and assessments (side A) has fallen under the "tests and measurement" umbrella of content validity. That is, to what extent does the test measure the important curricular objectives? This remains an important question, as evidenced by recent studies conducted by Buckendahl, Plake, Impara, and Irwin (2000), Kendall (1999), and Webb (1999).

Both content coverage and opportunity to learn, as defined by Burstein (1993), have to do with the relationship of instructional activities and materials with assessments (side C). The primary difference between the two concepts is where the analysis begins. Studies of content coverage typically begin with an examination of the instructional activities and materials (particularly the materials). The question is, "Is what we are teaching being tested?" Examples of early studies of content coverage

THEORY INTO PRACTICE, Volume 41, Number 4, Autumn 2002

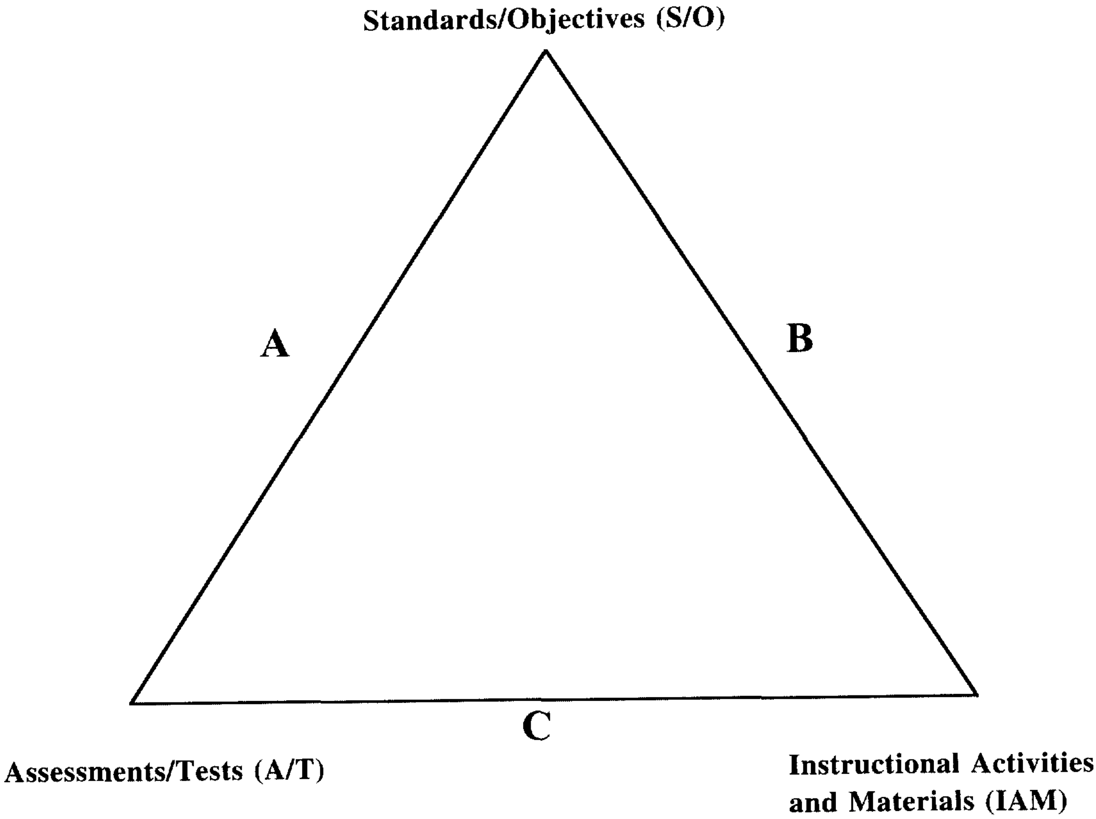

Figure 1. Relationships Among Standards/Objectives, Instructional Activities and Materials, and Assessments/Tests.

include Good, Grouws, and Beckerman's (1978) study of the relationship of the number of textbook pages covered with mathematics achievement test scores, and Anderson, Evertson, and Brophy's (1979) study of the number of basal readers completed by first-grade reading groups in relation to reading achievement test scores. More recent studies of content coverage have been reported by Elia (1994), Gamoran, Porter, Smithson, and White (1997), Kim (1993), Muthen et al. (1995), and Schmidt and McKnight (1995).

In contrast to content coverage, studies of the opportunity to learn typically begin with an examination of the assessment tasks or test items. The question is, "Are we teaching what is being tested?" Cooley and Leinhardt (1980), for example, asked teachers to estimate the percentage of their students who had been taught the minimum material necessary to pass each item on a standardized achievement test. In a related study, Leinhardt, Zigmond, and Cooley (1981) asked teachers to indicate whether each student or sample of students had been taught the information required to answer specific test items. Similarly, Winfield (1993) asked teachers to rate each of 34 test items on a five-point scale in terms of "(a) the number of times a mathematics concept was taught, (b) the frequency of review or reteaching the concept, (c) the number of settings in which the particular test format was used to teach the concept, (d) the frequency of usage of the format, (e) the extent to which the concept was emphasized in the school reading program, and (f) the teachers' perceptions of students' mastery of the concept" (p. 292).

If content validity studies focus on side A of the triangle depicted in Figure 1, and content coverage and opportunity to learn studies focus on side C of the triangle, then two questions remain.

First, what about side B of the triangle? Second, where does curriculum alignment fit into all of this? With respect to the first question, there have been several studies of the relationship of objectives to instructional activities and materials. However, no general term has been used to group these studies. Ippolito (1990), for example, examined the relationship between instructional materials and "criterion objectives" (p. 1). Similarly, NC HELPS (1999) focused on the way the curriculum was taught to ensure that it was consistent with the content of the curriculum as specified in the North Carolina "Standard Course of Study." Finally, Pickreign and Capps (2000) compared the "geometry language" used in K-6 textbooks with the language found in mathematics standards documents.

With respect to the second question, curriculum alignment is represented by the entire triangle in Figure 1. That is, curriculum alignment requires a strong link between objectives and assessments, between objectives and instructional activities and materials, *and* between assessments and instructional activities and materials. In other words, content validity, content coverage, and opportunity to learn are all included within the more general concept of "curriculum alignment."

Over the years, researchers have come to realize the importance of designing studies of sufficient complexity to examine the complete set of interrelationships included in Figure 1. However, only a few such studies currently exist. One noteworthy example, a study conducted by Breitsprecher (1991), examined the relative effects of two instructional activity variables (verbal mediation and feedback monitoring) and two levels of content validity (high and low) on student achievement. The results of the study suggest that all three variables—verbal mediation, feedback monitoring, and content validity—were significantly related to student achievement. However, content validity exerted a slightly greater influence than either of the instructional activity variables.

A Framework for Analyzing Curriculum Alignment

Although there are several methods used to collect data on curriculum alignment (Harskamp & Surhre, 1994; Winfield, 1993), relatively few analytical frameworks exist for making sense of the data collected from curricular alignment studies. Without an appropriate framework, the interpretation of the data remains rather problematic. Consider, for example, questions often asked of teachers in curricular alignment studies:

- What percent of students have been taught the minimum material needed to pass this item? (Cooley and Leinhardt, 1980)
- To what extent is this item/objective emphasized in the school mathematics curriculum for fourth grade? (Winfield, 1993)
- Have you taught the mathematics material needed to answer the item correctly? If you have not taught it, was it because (a) the topic had been taught the prior year, (b) the topic will be taught later, (c) the topic is not in the school curriculum at all, or (d) the topic was not taught for other reasons? (McDonnell, 1995)

Terms and phrases such as "minimum material," "mathematics material," "topic," and "item/objective" are certainly open to multiple interpretations.

A few attempts have been made to design appropriate analytic frameworks (see, for example, Webb, 1999). Gamoran and his colleagues (1997) developed one of the most comprehensive frameworks in this regard. Their framework consists of 10 general areas of mathematics, with each area divided into 7-10 specific topics, and six levels of "cognitive demand." Overall, this framework "yielded 558 specific types of content that might have been taught and/or tested" (p. 329). Although this framework clearly moves us in the right direction, it suffers from at least three major problems. First, with 558 cells, it is too cumbersome to be useful to most teachers. Second, it is likely to result in an underestimate of curriculum alignment. For example, Gamoran and his colleagues found that only 19 of the 558 cells were included on the primary test they examined. This initial finding led them to a more detailed examination of the cells that were included on the test. Third, the framework is limited to mathematics. Thus, similar alternative frameworks would be needed for all other subject matters.

The Taxonomy Table is a useful framework for estimating curriculum alignment in all subject matters at virtually every grade or school level. It addresses each of the three problems associated with the Gamoran et al. framework. First, it contains 24 cells (not 558). Furthermore, as illustrated by the vignettes included in the revised Taxonomy volume and the Ferguson and Byrd articles (this issue), teachers can use the framework to examine and enhance curriculum alignment. Second, because alignment is estimated in terms of the relationships of objectives, instructional activities and materials, and assessments with the Taxonomy Table, rather than with each other, the alignment process (a) focuses quite directly on student learning and (b) yields reasonably valid estimates of alignment. Third, as mentioned earlier, the Taxonomy Table is generic. By replacing topics with types of knowledge, the Taxonomy Table can be used with all subject matters.

Using the Taxonomy Table to Estimate Curriculum Alignment

The vignettes included in the revised Taxonomy volume and the articles written by Ferguson and Byrd (this issue) illustrate quite nicely the process used to estimate curriculum alignment with the aid of the Taxonomy Table. Before the process is described, it must be emphasized that alignment estimates using the Taxonomy Table are based on curriculum units or entire courses, not individual lessons. Thus, the analysis involved a group of objectives, a variety of instructional activities, and, generally, more than one assessment (both formal and informal). Having said this, the alignment process involves four steps.

First, each objective is placed in its appropriate cell or cells of the Taxonomy Table. The verbs and nouns included in the statement of the objective are used to place the objective in the proper cell. Second, each instructional activity (and accompanying support materials) is similarly placed in its appropriate cell, based once again on clues provided by verbs and nouns included in the description of the activity. Third, using clues from included verbs and nouns, each assessment task (whether it be a performance assessment or one of a series of test items) is placed in its appropriate cell. In the case of traditional tests, each item is considered an assessment task and placed appropriately. Fourth, the three completed Taxonomy Tables, one each derived from the analysis of the objectives, instructional activities and materials, and assessments, are compared. Complete alignment is evidenced when there are common cells included on all three completed Taxonomy Tables. That is, the objective, instructional activities and materials, and assessments all fall into the same cell (e.g., understand conceptual knowledge). Partial alignment also exists. For example, the objective, instructional activities and materials, and assessments may all fall into the same row (i.e., type of knowledge), but differ in terms of the column in which they are classified (i.e., cognitive process category). Similarly, the objective, instructional activities and materials, and assessments may all fall into the same column, but differ in terms of the row in which they are classified. Partial alignment provides potentially useful diagnostic information to teachers who want to improve their curricular alignment. Moving an instructional activity from an emphasis on *factual knowledge* to an emphasis on *procedural knowledge,* or from *understand* to *analyze* may be worth the effort if alignment is substantially improved.

Before concluding, two final points must be made. First, there is increasing evidence that estimating curriculum alignment based on both knowledge and cognitive processes is superior to other methods of estimating alignment. This research is summarized concisely by Gamoran and his colleagues (1997). "Clearly, to predict student achievement gains from knowledge of the content of instruction, a micro-level description of content that looks at cognitive demands by [type of knowledge] is the most useful approach considered to date" (p. 331).

Second, alignment, using the Taxonomy Table, is based on considering what teachers intend in terms of student learning. This is particularly important to keep in mind when analyzing instructional activities. When examining instructional activities, one must ask, "What is the student supposed to learn from his or her participation in this activity? What knowledge is to be acquired or constructed? What cognitive processes are to be employed?" Without answers to these questions, it is impossible to properly classify instructional activities in terms of the Taxonomy Table.

The Value of Curriculum Alignment

Even if the reader is convinced that the Taxonomy Table is a useful tool for estimating and increasing curriculum alignment, one question remains: Why should teachers be concerned about curriculum alignment? At least four answers to this question can be given.

The first is foreshadowed by the quotations with which this article began. Leigh Burstein was correct. We need to be more concerned with what students have learned as a result of their schooling experience than with what they know and can do regardless of the source of that knowledge or those skills. Bill Schmidt and Curtis McKnight also were right. Providing or denying opportunities to learn results in a very different education for different students. In summarizing the results of their research in New Zealand, Adrienne Alton-Lee and Graham Nuthall stated: "Our exploratory studies revealed that the curriculum excluded or marginalized people by race and gender . . . and that these processes led to different experiences for different . . . students" (p. 6). Or, in the words of Linda Winfield, opportunity to learn "emphasizes the importance of instruction and school factors in student achievement, and it avoids the 'blame the victim' mentality which focuses solely on students" (p. 307). In this regard, there is increasing evidence that the impact of opportunity to learn on student achievement is considerably greater for minority students than for their "advantaged" counterparts (Elia, 1994).

A second reason for the importance of curriculum alignment is that proper curriculum alignment enables us to understand the differences in the effects of schooling on student achievement. This is clearly evidenced by the research reported by Gamoran and his colleagues. The study focused on the success of so-called "transition" mathematics courses in California and New York. These transition courses were designed to bridge the gap between elementary and college-preparatory mathematics and to provide access to more challenging and meaningful mathematics for students who enter high school with poor skills. Based on their study, Gamoran et al. conclude that: "More rigorous content coverage distinguishes college-preparatory math classes from general-track math classes, and it also shows that, consistent with previous research, students learn more in the college-preparatory classes" (p. 333). Consequently, "low-achieving high school students are capable of learning much more than is typically demanded of them. The key is to provide a serious, meaningful curriculum: 'hard content for all students'" (p. 336).

A third reason for the importance of curriculum alignment is that poorly aligned curriculum results in our underestimating the effect of instruction on learning. Simply stated, teachers may be "teaching up a storm," but if what they are teaching is neither aligned with the state standards or the state assessments, then their teaching is in vain. This is the educational equivalent of a tree falling in the forest with no one around . . . no demonstrated learning, no recognized teaching.

A fourth, and final, reason for the importance of curriculum alignment stems from the current concern for educational accountability. Actually, *current* is probably not the correct word to use here. Over the past quarter century, the responsibility for accountability has shifted from students (and their home backgrounds) to schools. Regardless of the focus, however, curriculum alignment is central to the success of accountability programs. More than 20 years ago, the NAACP filed a lawsuit against the state of Florida (*Debra P. v. Turlington,* 1979) arguing that it was unconstitutional to deny high school diplomas to students who had not been given the opportunity to learn the material covered on a test that was a requirement for graduation. The court placed a four-year moratorium on administration of the test for diploma denial, arguing that this additional period of time was necessary to allow students to have an opportunity to learn the necessary knowledge and skills. Although the emphasis has shifted from student to school, the issue has not changed substantially. As Baratz-Snowden (1993) has asserted: "If students are to be held accountable for their learning, then schools must be held accountable as well by demonstrating that they provide students with opportunities to learn to meet the standards that have been set" (p. 317).

References

Alton-Lee, A., & Nuthall, G. (1992). Children's learning in classrooms: Challenges in developing a methodology to explain "opportunity to learn." *Journal of Classroom Interaction, 27*(2), 1-2.

Anderson, L., Evertson, C., & Brophy, J. (1979). An experimental study of effective teaching in first grade reading groups. *Elementary School Journal, 79*, 193-223.

Baratz-Snowden, J.C. (1993). Opportunity to learn: Implications for professional development. *Journal of Negro Education, 62*, 311-323.

Breitsprecher, C.H. (1991). *Relative effects of verbal mediation, feedback monitoring, and alignment on community college learners' achievement.* Unpublished doctoral dissertation, University of San Francisco. (ERIC Document Service No. ED333914)

Buckendahl, C.W., Plake, B.S., Impara, J.C., & Irwin, P.M. (2000, April). *Alignment of standardized achievement tests to state content standards: A comparison of publishers' and teachers' perspectives.* Paper presented at the annual meeting of the National Council on Measurement in Education, New Orleans. (ERIC Document Service No. ED442829)

Burstein, L. (1993). Studying learning, growth, and instruction cross-nationally: Lessons learned about why and why not engage in cross-national studies. In L. Burstein (Ed.), *The IEA study of mathematics III: Student growth and classroom processes* (pp. 27-49). Oxford, England: Pergamon.

Burstein, L., & Winters, L. (1994, June). *Workshop on models for collecting and using opportunity to learn at the state level.* Unpublished material, Albuquerque, NM.

Cooley, W.W., & Leinhardt, G. (1980). The instructional dimensions study. *Educational Evaluation and Policy Analysis, 2*, 7-25.

Elia, J. (1994). An alignment/transfer experiment with low socioeonomic level students. *Teacher Education Quarterly, 21*, 113-124.

Gamoran, A., Porter, A.C., Smithson, J., & White, P.A. (1997). Upgrading high school mathematics instruction: Improving learning opportunities for low-achieving, low-income youth. *Educational Evaluation and Policy Analysis, 19*, 325-338.

Good, T., Grouws, D.A., & Beckerman, T. (1978). Curriculum pacing: Some empirical data in mathematics. *Journal of Curriculum Studies, 10*, 75-82.

Harskamp, E., & Suhre, C. (1994). Assessing the opportunity to learn mathematics. *Evaluation Review, 18*, 627-642.

Ippolito, T.J. (1990). *An instructional alignment program for eighth grade criterion referenced math objectives.* Unpublished manuscript. (ERIC Document Service No. ED326432)

Kendall, J.S. (1999). *A report on the matches between the South Dakota standards in mathematics and selected Stanford Achievement Tests.* Unpublished manuscript. (ERIC Document Service No. ED447170)

Kim, H. (1993). A comparative study between an American and a Republic of Korean textbook series' coverage of measurement and geometry content in first through eighth grades. *School Science and Mathematics, 93*(3), 123-126.

Leinhardt, G., Zigmond, N., & Cooley, W. (1981). Reading instruction and its effects. *American Educational Research Journal, 18*, 343-361.

McDonnell, L.M. (1995). Opportunity to learn as a research concept and a policy instrument. *Educational Evaluation and Policy Analysis, 17*, 305-322.

Muthen, B., Huang, L-C., Jo, B., Khoo, S-T, Goff, G., Novak, J., & Shih, J. (1995). Opportunity-to-learn effects on achievement: Analytical aspects. *Educational Evaluation and Policy Analysis, 17*, 371-403.

NC HELPS. (1999). *Curriculum alignment.* Unpublished manuscript. (ERIC Document Service No. ED439526)

Pickreign, J., & Capps, L.R. (2000). Alignment of elementary geometry curriculum with current standards. *School Science and Mathematics, 100*, 243-245.

Schmidt, W.H., & McKnight, C.C.(1995). Surveying educational opportunity in mathematics and science: An international perspective. *Educational Evaluation and Policy Analysis, 17*, 337-353.

Webb, N.L. (1999). *Alignment of science and mathematics standards and assessments in four states.* Unpublished manuscript. (ERIC Document Service No. ED440852)

Winfield, L.F. (1993). Investigating test content and curriculum content overlap to assess opportunity to learn. *Journal of Negro Education, 62*, 288-310.

Additional Resources for Classroom Use

Krathwohl, A Revision of Bloom's Taxonomy: An Overview (pp. 212-218)

1. Hannah, L.S., & Michaelis, J.U. (1977). *A comprehensive framework for instructional objectives: A guide to systematic planning and evaluation.* Reading, MA: Addison-Wesley.

   The authors posit three major categories: Intellectual Processes, which is their cognitive domain; Skills, their psychomotor domain; and Attitudes and Values, their affective domain. All three are supported by the category of Data Gathering, which includes Observing and Remembering. Their Intellectual Processes category includes many of the cognitive processes presented in this issue of *TIP*. The authors claim these Intellectual Processes are arranged in hierarchical order; they did not reverse the order of evaluation and synthesis as done in the revised Taxonomy. Included are sample objectives and test items for each category.

2. Hauenstein, A.D. (1988). *A conceptual framework for educational objectives: A holistic approach to traditional taxonomies.* Lanham, MD: University Press of America.

   Like Hannah and Michaelis (above), Hauenstein sought to bring consistency to all three domains by establishing a base definition and set of criteria for the Taxonomy. He also uses verbs or gerunds and many of the original criteria and categories. As discussed in this issue, the author inverts evaluation and synthesis. In addition, he adds a new domain, the Behavioral Domain, which "capsulizes and summarizes the co-requisite objectives of the cognitive, affective and psychomotor domains" (p. 115). The text also describes the process of learning over time in five categories: acquisition, assimilation, adaptation, performance, and aspiration.

3. Marzano, R.J. (2001). *Designing a new taxonomy of educational objectives.* Thousand Oaks, CA: Corwin Press.

   Presented here is Marzano's taxonomy, which is based on a flow of processing model that successively passes through three hierarchically related systems of thinking, and constitutes the six levels of what would be most comparable to our process dimension: Self system, Metacognitive system, and, finally, the four levels of the Cognitive system: Retrieval, Comprehension, Analysis, and Knowledge Utilization. The author applies the taxonomy to curriculum assessment design.

Pintrich, The Role of Metacognitive Knowledge in Learning, Teaching, and Assessing (pp. 219-225)

1. Bransford, J., Brown, A., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

   This book reviews recent cognitive science research on learning and teaching in a nontechnical and easily understood style. While there are few specific practical suggestions for teaching, the book as a whole provides a good introduction of current cognitive science and its applications to learning and teaching.

2. Zimmerman, B.J., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners: Beyond achievement to self-efficacy.* Washington, DC: American Psychological Association.

   This short guide for teachers is part of the *Psychology in the Classroom* series of the American Psychological Association, which focuses on applying principles and findings from educational psychology. It outlines how a self-regulatory learning cycle can be implemented to enable middle and secondary school students to develop five essential academic skills: planning and using study time, understanding and summarizing text material, note taking, anticipating and preparing for exams, and effective writing.

3. Jones, B., Rasmussen, C., & Moffitt, M. (Eds.). (1997). *Real-life problem solving: A collaborative approach to interdisciplinary learning.*

Washington, DC: American Psychological Association.

Part of a series on the application of educational psychology to the classroom, this book discusses problem-based learning and how to implement it in the classroom. Because the book and the series are aimed at teachers, there are plenty of pragmatic suggestions for classroom instruction.

Mayer, Rote Versus Meaningful Learning (pp. 226-232)

1. Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

   Chapter 5, The Cognitive Process Dimension, provides an in-depth description of the cognitive processes involved in meaningful learning.

2. Mayer, R.E. (1999). *The promise of educational psychology, Volume I: Learning in the content areas.* Upper Saddle River, NJ: Prentice Hall.

   Mayer, R.E. (2001). *The promise of educational psychology, Volume II: Teaching for meaningful learning.* Upper Saddle River, NJ: Prentice Hall.

   This two-volume set examines how children learn from different methods of instruction. It profiles methods such as feedback, guided exploration, cognitive apprenticeship, problem-based learning, and teaching of problem-solving strategies that allow learners to take what they have learned and apply it to new situations. The author presents research on learning and instruction for meaningful learning and discusses how to apply this information to teaching.

Raths, Improving Instruction (pp. 233-237)

1. Wiske, M.S. (Ed.). (1998). *Teaching for understanding.* San Francisco: Jossey Bass.

   This volume reports on the findings of Project Zero, a Harvard Graduate School of Education effort to explore ways of teaching to higher levels of objectives. While the book is indeed helpful, the complexity of teaching for understanding is underscored in the narratives included here.

2. Wiggins, G., & McTighe, J. (1998). *Understanding by design.* Alexandria, VA: ASCD.

   A magnificent supplement to the accounts of Bloom's taxonomy, the narrative spells out how teachers can plan "backwards," beginning with the assessment and working back toward the design of learning activities. Alignment is the key here.

3. Marzano, R.J., Pickering, D.J., & Pollock, J.E. (2001). *Classroom instruction that works.* Alexandria, VA: ASCD.

   A key to improving instruction is for teachers to attempt to reduce the time it takes students to acquire the learning targets. This book describes nine teaching strategies that can do just that. While not all of the strategies are new—some might even be familiar—there is a variety presented here to stimulate and challenge all teachers.

4. Carroll, J.B. (1963). A model of school learning. *Teachers College Record, 64,* 723-733.

   Teachers should be interested in reading the original source of the model that has guided so many instructional improvement efforts for the past 40 years or so. Carroll's model, elegant in its parsimony, suggests that teachers must find ways to reduce the time students need to learn and increase the time students spend on task. The presentation here is clear and compelling.

5. Marzano, R.J. (2001). *A step toward redesigning Bloom's taxonomy.* Thousand Oaks, CA: Corwin Press.

   Marzano's book is an "attempt to articulate a taxonomy of educational objectives that uses the best available research and theory accumulated since the publication of Bloom's taxonomy" (p. viii). The heart of Marzano's taxonomy is his analysis of six levels of thinking: retrieval, comprehension, analysis, knowledge utilization, metacognition, and self-system thinking. He further divides information into details and organizing ideas, and mental procedures into skills and process. In many respects, Marzano's taxonomy is similar to the revision described in this issue of *TIP*. At the same time, there are notable differences that should be evident to those reading both volumes.

Ferguson, Using the Revised Taxonomy to Plan and Deliver Team-Taught, Integrated, Thematic Units (pp. 238-243)

1. Meinbach, A.M., Rothlein, L., & Fredericks, A.D. (2000). *The complete guide to thematic units: Creating the integrated curriculum* (Rev. ed.). Norwood, MA: Christopher-Gordon.

   Aimed at teachers of primary through intermediate grades, this guide is divided into two parts. Part I contains information about the value of a thematic approach to teaching, practical strategies for success, options for assessment (including the use of portfolios), and suggestions for involving parents and the community. Part II contains outlines of 19 sample units for primary and secondary classrooms accompanied by stories that demonstrate their use in actual classrooms for each sample unit. Teachers can either use the projects as they are or adapt them to fit their needs.

2. Short, K.G., Schroeder, J., Laird, J., Kauffman, G., Ferguson, M.J., & Crawford, K.M. (1996). *Learning together through inquiry: From Columbus to integrated curriculum.* Portland, MA: Stenhouse Publishers.

   This book tells the story of how six teachers collaborated with each other and with their students to explore and negotiate curriculum as inquiry. As a result of this process, the teachers found they had moved from textbook-based curriculum to thematic units, ones in which students were involved in a range of activities and a range of topics and issues. Students engaged in inquiries about Christopher Columbus, changes in families over time, personal and family history, slavery, human rights, cultures, space, and nature cycles.

Byrd, The Revised Taxonomy and Prospective Teachers (pp. 244-248)

1. Feinman-Nemser, S., & Parker, M.B. (1990). *Making subject matter part of the conversation or helping beginning teachers learn to teach.* East Lansing, MI: National Center for Research on Teacher Education.

   Feinman-Nemser and Parker present the results of conversations with experienced and beginning teachers concerning the role of subject matter content in learning to teach. Based on these conversations, the authors identified four aspects of learning to teach academic content: (a) deepening one's own understanding of subject matter, (b) learning to think about academic content from the student's perspective, (c) learning to represent subject matter in appropriate and engaging ways, and (d) learning to organize students for the purposes of teaching and learning academic content.

2. Feinman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*, 1013-1055.

   The author proposes a curriculum for teacher learning over time. She examines the "fit" among conventional teacher education, induction into the profession, and continual professional development, with an eye on the challenges of improving one's teaching during one's career. Feinman-Nemser examines the central tasks of teacher preparation, induction, and professional development; how well conventional approaches to teacher education address these tasks; and promising programs and practices at each stage of learning.

Airasian and Miranda, The Role of Assessment in the Revised Taxonomy (pp. 249-254)

1. Airasian, P.W. (2000). *Classroom assessment: Concepts and applications* (4th ed.). New York: McGraw-Hill.

   Airasian conceives of classroom assessment more broadly than the authors of many other classroom assessment texts. The focus is not only on the assessment needs of testing, grading, interpreting standardized tests, and performance assessments, but also on assessment concerns in organizing a classroom at the start of school, planning and implementing instruction, and strategies of teacher self-reflection. Airasian views classroom assessment as an everyday, ongoing, integral part of teaching, not something that is separated from life in classrooms. The organization of the text follows the natural progression of teacher decision making—from organizing the class as a learning community to planning and conducting instruction to the formal evaluation of learning, and, finally, to grading.

2. Stiggins, R.J. (2001). *Student-involved classroom assessment* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

   Using a jargon-free writing style, Stiggins shows teachers how to create high-quality classroom assessments and use them to build student confidence, thereby maximizing (not just documenting) student achievement. This emphasis is on what teachers need to know to manage day-to-day classroom assessment effectively and efficiently. The author offers practical guidelines on how to construct all types of assessments, providing clear and understandable explanations of how to match achievement targets to assessment methods. Traditional concepts of validity and reliability are integrated within his overall assessment framework.

Anderson, Curricular Realignment: A Re-examination (pp. 255-260)

1. English, F.W., & Steffy, B.E. (2001). *Deep curriculum alignment: Creating a level playing field for all children on high-stakes tests of educational accountability*. Lanham, MD: Scarecrow Press, Inc.

   English and Steffy explore the flaws in state-mandated testing, advocating a more comprehensive approach to teaching and testing. This highly practical book helps educators design a deeply aligned curriculum that produces academic results and a level playing field for all students. Each chapter covers principles of testing and curriculum building, and concludes with a summary of the key concepts presented. The results of various studies are surveyed, ethical dilemmas involved in testing are discussed, and a step-by-step guide to pedagogical parallelism and alignment is presented.

2. Herman, J.L., Klein, D.C., & Abedi, J. (2000). Assessing students' opportunity to learn: Teacher and student perspectives. *Educational Measurement: Issues and Practices, 19*(4), 16-24.

   Herman, Klein, and Abedi explore various methods of assessing opportunity to learn, using both teacher and student reports. They investigate the integrity of various dimensions of opportunity to learn, analyze the relationship between teacher and student estimates of opportunity to learn, and draw implications for policy and practice. The conceptual link between opportunity to learn and test validity is explored and recommendations are offered.

3. Relearning by Design web site
   www.relearning.org

   This website, initiated by Grant Wiggins, focuses on performance assessment, rubrics for evaluating the quality of student performances, and the way in which assessment information can be used to inform teachers and improve instruction. This is an excellent resource for teachers who are interested in improving their knowledge and skills in the area of the nexus of instruction and assessment.