PART VI

Thinking and Organizing the Content

Examining the content and choosing the best way to approach the organization of the material is the focus of this final type of instruction. How can I best organize the concepts that belong to a subject to enhance the learning process? What do I need to know about the content in relation to the students' perceptions of the things to be learned? This section represents more than just the teacher's knowledge of content; it is the concepts within the content that determine learning outcomes. What patterns exist between and among the concepts that can be organized to enhance student learning?

In Part VI, Chapter 12 examines thinking patterns, Chapter 13 explores memorization, Chapter 14 looks at attaining concepts, and Chapter 15 investigates inquiry.

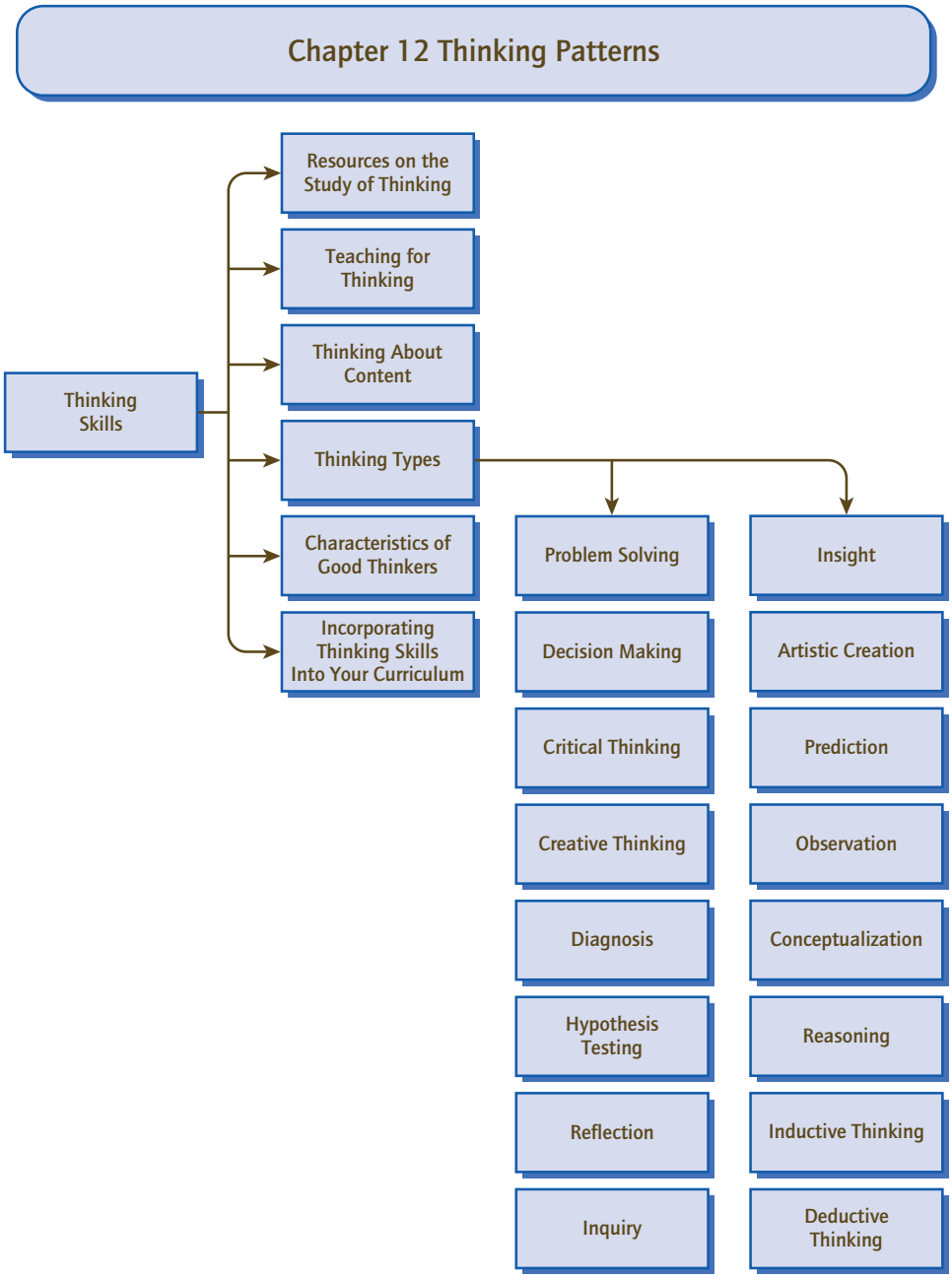
CHAPTER 12

Thinking Patterns

AMERICAN SCHOOLS HAVE ALWAYS BEEN CONCERNED WITH PROVIDING THEIR STUDENTS APPROPRIATE education so that they can become productive citizens within our society. However, the way we define "productive citizens" has changed as American society has changed. As our public schools have accepted the responsibility of educating all children regardless of race, ethnicity, gender, or special needs and as laws and court decisions have struck down discriminatory practices in the hiring of personnel in our businesses and industries, schools have had to adjust and adapt their curricula to meet the learning potential of all of these students. Thus, the knowledge and skills that are necessary for equal access to employment have become a priority of public education. As schools strive to meet the demands of employers, the curriculum fluctuates according to the postsecondary needs of students, whether that means immediate employment or further education.

If you were to examine school curriculum over the past 50 years, you would see an emphasis on basic skills, inclusion of vocational education and career exploration, attention to values clarification and character education, a push for the development of higher-order thinking skills, attention to (or sometimes a lack thereof) the fine arts, introduction of physical fitness into physical education programs, introduction of social justice and civil rights education, a huge push for more mathematics and science (particularly following the *Sputnik* launch), and all kinds of special needs programs. Currently, we find a rigid back-to-basics approach and high-stakes testing curriculum with few provisions for the variety of needs of today's students.

Many of the attempts to change the school curriculum were not necessarily good choices because there was little research that could tell educators what really works and what does not work. Many students were tracked into programs and deprived of educational opportunities because of decisions made about their academic potential. Some students, because of parental concern, were placed in programs that were not appropriate for their academic potential. Needless to say, all of our attempts to design curricula that meet the needs of all students have not always been successful and could be subjected to lots of criticism, some of which is justified.



However, in all of these attempts to best meet the needs of the changing population of American schools and changing society, one fact is certain. Students cannot be successful in postsecondary environments unless they leave the K–12 system with strong reading, writing, arithmetic, and thinking skills. Much attention, particularly now, has been focused on the development and improvement of reading, writing, and arithmetic skills, whereas little attention has

been devoted to the development and improvement of thinking skills. Too often, it is assumed that by having students work through English, science, social studies, and mathematics classes, they will develop appropriate thinking skills. The reality is that most students do not develop these skills without some instructional help from their teachers.

Students rarely see the transferability of thinking skills that are taught in one subject area—for example, problem solving in science—to other content areas, such as mathematics or social studies (Adams, 1991). Also missing from educators' understanding is the realization that thinking skills are not necessarily subject specific. Creative thinking should not be relegated to the domain of the English teachers and fine arts teachers. If scientists were not capable of thinking creatively and "outside the box," man would never have walked on the moon; we would never have been able to view the exploration of Mars by rovers launched into space or see the rings of Saturn with such clarity and awe. We would not have the technology we now take for granted, nor would we have medicines to prevent the diseases that killed our forefathers. If our musicians and artists were incapable of solving problems or using critical-thinking skills, we would not have the variety of music we listen to, the fantastic films we watch, the computer-based graphics we have come to rely on, or the virtual tours of museums we can now enjoy.

This chapter will examine the types and ways of thinking that should be included in every curriculum and thinking-skills strategies that can be incorporated into different models of teaching. Because the organization of content and the thinking skills needed to use that content are inextricably connected, it is imperative that you understand the relationship between content and thinking skills. Different thinking-skills programs will be explored to inform you of the options if you are working with students who need a different approach to learning how to think. In addition, the concept of metacognition and its importance to your understanding of thinking skills will be addressed.

RESEARCH ANCHOR

Probably one of the best resources devoted to the study of thinking skills is a publication of the Association for Supervision and Curriculum Development titled *Developing Minds,* edited by Art Costa (1991). This two-volume publication sorts through the research on thinking skills, methods of teaching thinking skills, and programs for teaching thinking skills. In the introductory chapters, a case is made for teaching thinking skills in the curriculum based on statistics gathered from various sources: National Assessment of Educational Progress (NAEP) reports; the Education Commission of the States (1982); the Institute for the Study of Human Knowledge (Ornstein 1980); the NAEP's *Mathematics Report Card—Are We Measuring Up?* (Dossey, Mullis, Lingquist, & Chambers, 1988), *Science Report Card—Elements of Risk and Recovery* (Mullis & Jenkins, 1988), and *Writing Report Card, 1984–1988* (Applebee, Langer, Mullis, & Jenkins, 1988); as well as books and reports such as *A Place Called School* (Goodlad, 1984) and *A Nation at Risk* (National Commission on Excellence in Education, 1983).

In addition, the annual Gallup Poll of Teachers' Attitudes Toward the Public Schools, published yearly by Phi Delta Kappa, consistently shows that teachers are very concerned about the need to teach thinking skills to students. The data gathered in these reports can be summarized as follows:

- Although students' performance in reading, writing, mathematics, and science proficiency is improving, that improvement is still relegated to the lower levels of Bloom's taxonomy. Students are not demonstrating sufficient skills at the higher levels of thinking (see the National Center for Education Statistics' Condition of Education indicators, available at http://nces.ed.gov/programs/coe/).
- With increasing societal pressures, such as energy production, population growth, environmental concerns, employment and health issues, and economic and social problems, students need to develop quality thinking skills to be efficient and effective problem solvers and decision makers in the future (Ornstein, 1980).
- Mathematics skills are improving, but for students ages 9, 13, and 17, most of the progress has been made at the lower levels; students need to develop higher-order thinking skills in mathematics (Dossey et al., 1988, p. 12).
- Recent improvements in science have occurred at the lower levels of thinking and basic knowledge acquisition. Few students demonstrate higher-level skills (Mullis & Jenkins, 1988, pp. 19–20).
- Although students ages 9, 13, and 17 can perform minimal responses, few students demonstrate skills reasoning and the use of higher-order thinking strategies (Applebee et al., 1990, p. 40).
- According to Goodlad's (1984) study of 1,000 classrooms in communities across the country, 75% of class time was spent on instruction. Seventy percent of that time was teacher controlled, and of that share, teachers only engaged students in higher-order thinking 1% of the time.

As you read through current literature on thinking skills, the concerns remain much the same. Teachers are working hard in the classroom to ensure that students can perform adequately on the high-stakes tests that are being used to evaluate our schools, but much of that testing is still focused on knowledge acquisition rather than the higher-order levels of thinking that are needed in today's complex society. The need for higher-order thinking is greater now than ever before in our history; it is imperative that you understand what the thinking skills are and how you can incorporate them into your teaching.

WHAT ARE THINKING SKILLS?

Children learn to think long before they ever come to school. In previous chapters, we explored how the brain functions and how we learn and develop knowledge. Young children, before they develop language facility of their own, learn by observation, sorting the input they receive, categorizing, and relating the information to previous observations, and they begin to build a knowledge base from which they can continue to learn. Language is learned through repetition and making relationships between sounds and objects. Young children do a great deal of experimentation and learn through trial and error as they grow up. For example, have you ever watched the "tasting habits" of young children? Mothers get upset as children keep placing objects in their mouths, but children instinctively do that and eventually, with some guidance from adults, discriminate edible objects from inedible ones. Through repetition, they learn the names of the objects they can eat. Children initially might call all four-legged animals dogs or cats (which ever is first known to them), but eventually they will distinguish dogs from cats, horses, cows, pigs, and other four-legged animals.

Educator Biography

Arthur L. Costa is an emeritus professor of education at California State University, Sacramento, and cofounder of the Institute for Intelligent Behavior in El Dorado Hills, California. He has served as a classroom teacher, curriculum consultant, assistant superintendent for instruction, and director of educational programs for the National Aeronautics and Space Administration. He has made presentations and conducted workshops in all 50 states as well as Mexico, Central and South America, Canada, Australia, New Zealand, Africa, Europe, Asia, and the Islands of the South Pacific.

Dr. Costa has devoted his career to improving education through more thoughtful instruction and assessment. He edited the book *Developing Minds: A Resource Book for Teaching Thinking* and is the author of *The Enabling Behaviors* and *The School as a Home for the Mind*. He is the coauthor of *Techniques for Teaching Thinking* (with Larry Lowery) and *Cognitive Coaching: A Foundation for Renaissance Schools* (with Bob Garmston), and the coeditor of *Assessment in the Learning Organization*, *Assessment Strategies for Self-Directed Learning,* the *Habits of Mind* series (with Bena Kallick), and the trilogy *Process as Content* (with Rosemarie Liebmann). His works have been translated into Dutch, Chinese, Spanish, Hebrew, and Arabic.

Active in many professional organizations, Dr. Costa served as president of the California Association for Supervision and Curriculum Development and was the national president of that organization from 1988 to 1989.

Part of this ability to distinguish is the child's ability to examine characteristics and to place that information with the language they hear from adults. All of this listening, trying, sorting, and naming are manifestations of various forms of thinking skills. Unless we are born with some physiological defect, most of our initial learning is created by the experiences we have in our environment and our ability to think about those experiences and put names on the various aspects of those experiences.

According to Howard Gardner (1982), much of our exploratory efforts to learn as young children are identical to the practicing that scientists and artists engage in when they create new knowledge and images. Unfortunately, however, this self-induced exploration ceases once we enter formal education. Current authors who support brain-based learning (Given, 2002; Jensen, 1998; Jones, 2003; Sprenger, 1999) all imply that what is wrong with what we do in school is that schools are "brain incompatible" (a term coined by Hart in 1975). To improve our students' learning and develop their thinking skills, you, as the teacher, need to create classroom conditions and activities that are conducive to student thinking. But what does this mean?

According to Costa (1991), teachers must teach for, of, and about thinking in their classrooms. Teaching for thinking means developing a classroom climate that engages students in their learning:

- You pose problems, raise questions, or create dilemmas and invite students to engage in problem solving.

- You positively respond to students' ideas, listen carefully to their thoughts, and help them to clarify and understand their thinking. You remain nonjudgmental as students explore ideas, and you encourage experimentation and risk taking.
- You model good thinking strategies in your teaching and interaction with students, colleagues, and parents.

By doing the above-mentioned activities, you establish a classroom climate that is conducive to teaching for thinking.

The teaching of thinking means direct instruction of specific thinking strategies. Some authors have indicated that separate courses specifically devoted to teaching of thinking ought to be included in the curriculum (e.g., de Bono, 1985; Feuerstein, 1980; Lipman, 1991), whereas others believe that the direct teaching of thinking skills can be incorporated into the existing curriculum (e.g., Beyer, 1987; Ennis, 1991; Marzano, 2003; Parnes, 1992; Pogrow, 1988; Presseisen, 1991). Regardless of whether a separate curriculum for the teaching of thinking skills is feasible, you need to be cognizant of your obligation to teach students how to engage in various forms of thinking while they are in your classroom. There are specific steps to follow to be a good problem solver, and students need to learn them and practice them. For your students to engage in creative thinking, they need to learn how to brainstorm and evaluate ideas. For students to be critical thinkers, they need to know the strategies of analysis, logical argument, and organization. These are all teachable skills that can be woven into your lessons and are not tied to specific content areas.

The third category of Costa's thinking is teaching about thinking. This is the *metacognitive* dimension of thinking. We have discussed metacognition in previous chapters, but as a reminder, metacognition is thinking about how we think. It is the self-awareness of how we process information and make sense out of what we are doing. Too often, teachers do not take the time to get their students thinking about what they have just done. Without this reflection, students often do not understand why they solved problems correctly or why their ideas about how to do something did not work.

Fundamental to metacognition is learning how to learn and helping students to understand which learning strategies work best for them. Are they auditory, visual, or kinesthetic learners? Are they good at problem solving but not creative thinking? Do they know how to ask questions to help them get on the right track before tackling an activity or assignment? Knowing about how they learn will help students make adjustments when they are confronted with tasks that ask them to work in areas that are not their strengths. Rather than getting frustrated and quitting, students can rearrange the tasks and clarify the expectations so that they can apply the skills that work best for them.

Two other areas that should be explored in teaching about thinking are knowing how our brain functions (this is particularly valuable as different learning strategies are introduced to students) and the study of how knowledge is produced (epistemic cognition). The latter knowledge was the basis for many of the curriculum reforms of the 1950s and 1960s in the areas of mathematics and science. The purpose of many of these programs—designed immediately after we were embarrassed by the Soviet Union's successful launch of *Sputnik*—was to help students think like scientists and mathematicians. The failure of these programs had much to do with the inability of teachers to teach science and mathematics from the perspective of the scientist or the mathematician. After all, they had not been taught that way, and most of them were not scientists or mathematicians. Although they were very knowledgeable about the subjects they

were teaching, they did not work in the field or use science and mathematics to solve problems or create new ideas. Without a thorough understanding of how content is used in the real world, it is difficult to teach it through the eyes of the artist, musician, scientist, geographer, mathematician, writer, or composer.

In today's environment, however, through the use of technology, there is far more information available to you that will help your students understand how knowledge is used and created in various fields. By studying the lives of philosophers, scientists, artists, and composers, students can begin to make comparisons about the kinds of thinking used by various individuals. Epistemological questions can be related to these comparisons. Students can use the Internet to contact novelists and ask them about their strategies for writing, how they get their ideas, how they structure their time, and how they overcome writer's block. Students can examine why certain forms of inquiry, such as problem solving, might not work as well for solving social problems as they do for solving scientific puzzles. They can watch some of the programs presented on cable channels such as Discovery, Animal Planet, the History Channel, and Lifetime, which focus many of their programs on how we gather information, process it, and learn from it. Paul and Elder (2003) suggest that each subject have its own systematic way of thinking about the content within that subject, and these ways can be found by examining the following elements:

- The purposes of the content
- The questions and issues generally attributed to that content
- The information within the content and how it is used
- The ideas and theories appropriate to interpret data from that content
- The concepts, theories, definitions, laws, principles, models, axioms of the content
- The assumptions about the content
- The implications and consequences generated by the content
- The perspectives or points of view attributed to that content

Although Paul and Elder identify these eight elements of thinking about content, they do not indicate that systematic ways of thinking about different content areas cannot overlap. Some of the same skills of thinking apply to a variety of content areas; however, it is imperative that students and teachers recognize that content is structured differently, and for us to be good thinkers about the content we are trying to learn, we must be cognizant of that structure. Knowing how content is structured, what kinds of questions need to be asked about that content, and what kind of thinking one needs to engage in to learn that content is also part of the metacognitive process—it is thinking about thinking.

Besides Costa's notion that we need to teach for, of, and about thinking, it is also important that we have a solid knowledge about the types of thinking that humans do. Various authors have chosen to define these types of thinking differently; the list that follows details the most common types of thinking that we do:

- Problem solving: resolving a known difficulty (Presseisen, 1991)
- Decision making: choosing a best alternative (Presseisen, 1991)

Metacognition is thinking about how we think.

- Critical thinking: understanding particular meanings, relationships, theories, and proofs (Presseisen, 1991)
- Creative thinking: developing new ideas or products (Presseisen, 1991)
- Diagnosis: troubleshooting (Glatthorn & Baron, 1991)
- Hypothesis testing: forming and testing hypotheses (Glatthorn & Baron, 1991)
- Reflection: searching for general principles or rules based on previously gathered evidence (Glatthorn & Baron, 1991)
- Insight: experiencing the "eureka phenomenon" or, as others have defined it, the light bulb going on; solutions come suddenly and with certainty (Glatthorn & Baron, 1991)
- Artistic creation: forming a synthesis, a deliberate search for goals that can be reproduced in a painting, poem, or musical composition (Glatthorn & Baron, 1991)
- Prediction: analyzing current evidence, placing it into the context of previous knowledge, and generating a position (Glatthorn & Baron, 1991)
- Observation: watching, listening, sorting, mimicking (Glatthorn & Baron, 1991)
- Conceptualizing: generalizing from specifics or inventing concepts or models (Beyer, 1987)
- Reasoning: inferring information systematically according to the rules of logic (Beyer, 1987)
- Inductive thinking: examining specific information to form a generalization according to the rules of logic (Beyer, 1987)

- Deductive thinking: reasoning from a known principle to an unknown or from the general to the specific according to the rules of logic (Beyer, 1987)
- Inquiry: having an awareness of problem-solving and critical-thinking skills and the ability to apply them to a given situation (Costa, 1991)

In addition to these types of thinking, you need only return to Bloom's taxonomy to see additional ideas about the types of thinking we do at the various levels of the taxonomy or revised taxonomy. The type of thinking that we do at the recall level, for example, is far different from the thinking we do at the application, analysis, evaluation, or synthesis levels. You need only look at the verbs that are used to form your learning objectives to realize there are different expectations for thinking at each level of the taxonomy.

As you examine the 16 different definitions of thinking listed here, you may begin to realize that they are not necessarily distinct—that is, in critical thinking, you would be expected to use reasoning skills, observation, and inductive and deductive strategies. In creative thinking, you would use skills of observation, prediction, artistic creation, and reflection. Likewise, problem solving and decision making incorporate some of the other identified thinking skills, such as inquiry, critical thinking, diagnosis, and conceptualizing, to name a few. Regardless of how we define thinking skills, the important thing to remember is that you need to help students develop their thinking skills across the curriculum areas. There are instructional strategies that are specifically designed to develop some of these thinking skills, whereas others are best developed by incorporating them into instructional strategies such as cooperative learning, direct instruction, and self-taught instruction.

In-service and staff development workshops facilitate ways that teaching can be taught.

CHARACTERISTICS OF GOOD THINKERS

If one of your goals is for your students to enhance their thinking skills, then you need to know the characteristics of good thinkers. Glatthorn and Baron (1991) developed the following list of characteristics of a good thinker:

- Welcomes problematic situations
- Tolerates ambiguity
- Is sufficiently self-critical
- Looks for alternative possibilities and goals
- Seeks evidence on both sides of an issue
- Is reflective and deliberative
- Searches extensively when appropriate
- Believes in the value of rationality
- Believes thinking can be effective
- Is deliberative in defining goals
- Revises goals when necessary
- Is open to multiple possibilities

A good thinker is someone who likes to engage in the thinking process and finds the process fun and exciting. A person may be a good thinker in one subject area but not necessarily in another, so you should not be quick to judge a student's ability to think. For example, it is not unusual to find a student who is an excellent thinker in mathematics but cannot analyze a story, find errors in grammar, or interpret a poem or sonnet. On the other hand, a student might be an extremely creative writer and storyteller but cannot make sense of chemical bond theory. It is possible that our inability to think effectively in some subject areas may have to do with Paul and Elder's (2003) notion that different subjects have different ways of thinking that are directly related to the structure of that subject; if we do not understand the structure of the subject, we may not be able to think effectively about the content. Much of how we think is influenced by what we are asked to think about. Subject matter has a powerful effect on one's thinking-skills development. That is why some researchers, such as Feuerstein (Link, 1991), have developed programs such as instrumental enrichment, which try to teach a variety of thinking skills in a "content-free" environment.

As you contemplate how you will infuse thinking-skills development into your curriculum, you need to set goals for your students. You need to assess where they are with respect to how they think in the content area you will be teaching. As you think about all of this, you can, as you write your lesson plans, determine where you might need to teach a certain type of thinking skill directly. You may need to think about alternatives if you assume that students have a thinking skill and come to discover in the course of your instructional strategy that they do not have the skill or cannot use the skill effectively. In planning your lesson, if you follow the guidelines suggested by Bloom's revised taxonomy, you will be able to determine where the teaching

of thinking skills belongs in your program. As you write objectives at higher levels, you will be automatically involved in thinking-skills development.

There are many resources available to you for teaching thinking skills in the classroom. You need only go on the Internet and type in "thinking skills lessons," and you will be bombarded with ideas and suggestions for the integration of thinking skills into your curriculum. You also need to examine the materials provided to you by the curriculum coordinator or resource person at your school; many of these materials have provisions for the teaching of thinking skills. Look closely at the teacher's guide to your textbooks and any supplemental materials that come with the textbook. Usually, these materials will have suggestions for the teaching of thinking skills specific to the content you are teaching.

If all else fails, remember a few basic things: The questions you ask your students should fall into the *why* and *how* categories rather than the *where*, *what,* and *when* categories. Insisting that students explain a phenomenon or a procedure helps them much more than simply identifying it or describing when it might be used. For example, it is far more important for students to be able to explain the decisions made by a character in a novel than to identify all the characters in the novel or attribute lines of text to an individual character. How many times were you asked to memorize phrases from poetry or plays and recite them on demand in class? How many of these passages do you remember now? Of what value was the activity of memorizing and reciting those passages? What do you remember about the rest of the poem, play, or story? Why do you think you were expected to read the poem, play, or story in the first place?

The same could be said for the study of history. How many dates and events and people do you remember from your world history classes? Can you explain the causes of World War I or World War II and the dilemmas faced by the Allied forces and the enemies during those wars? Can you explain why enemies are now friends and allies are now enemies? How could this knowledge help you to explain to your students the current engagements we find ourselves in the Middle East? Are there any similarities? Do you think you could have been taught differently, so that what you learned in high school might now be of value to you now as a teacher?

INCORPORATING THINKING SKILLS INTO YOUR CURRICULUM

To provide you with some easily adaptable techniques for incorporating thinking skills into the subject matter that you are teaching, we will focus on the four major categories of thinking: problem solving, decision making, critical thinking, and creative thinking.

Problem Solving

There are many different interpretations of problem solving, and part of the difference is directly related to how we use language in our subject fields. For example, in mathematics, we typically find the phrase, "solve the following problems," when what we really intend is for students to find the answers to these problems by applying the rules they just learned. Most of what is called "problem solving" in mathematics is not problem solving in the true sense of the term but the application of rules to find correct answers. Problem solving does occur in mathematics: for example,

when we are working with word problems, or in higher mathematics, when we are attempting to prove theorems and ideas.

Too often, problem solving is thought of as a skill that is used specifically in the sciences and is directly related to the scientific method. The scientific method does, in fact, identify a procedure that is applicable in the laboratory and is taught to all science students:

1. Identify the problem.
2. Formulate hypotheses.
3. Test the hypotheses.
4. Analyze the data.
5. Draw conclusions.

Depending on whose version of the scientific method you use, you may include more or fewer steps. However, the purpose is to provide a systematic means of working through a problem or dilemma. However, teachers and students often erroneously assume that the scientific method cannot be used in subjects other than the sciences. Because of terms such as "hypotheses" and "data analysis" are used, it is assumed that the procedure is only useful in experimental studies. Therefore, you might be more inclined to think of problem solving as it is described by George Polya in his seminal work *How to Solve It* (1957). Though Polya was a mathematician, in his book he described a four-stage method for general problem solving that is adaptable to any subject, from academics to life skills. His stages are as follows:

1. Understand the problem.
2. Devise a plan.
3. Carry out the plan.
4. Look back.

If the problem you are attempting to solve is a science problem, you can see how this general plan for solving a problem could easily be converted to the scientific method. If, on the other hand, you are trying to solve a word problem in mathematics, this plan works very nicely, as it does if you are examining a social problem, a literary dilemma, an architectural challenge, an engineering concern, or the production of an artistic piece.

There are many ways students can engage in understanding the problem—the key to solving the problem. They can draw diagrams, they can restate the problem in their own words and ask their teacher or peers if their translation is correct, or they can discuss the problem with their peers in pairs or groups. How students understand the problem is directly related to the complexity of the problem and the context in which it is presented. Research has shown that if the problem is not meaningful to the students, then they are less likely to be successful at finding a solution (Arnand & Ross, 1987; Ross, 1983; Wright and Wright, 1985).

Students need to be taught how to strategically design plans to solve problems. Again, what is taught in these strategic plans is usually directly related to the context of the problem. Different content areas may use different strategies to design a plan. Problems in the sciences are usually solved in a lab, where strict procedures are followed. In mathematics, different schema for

Educator

Biography

George Polya (1887–1985) was a mathematics educator at Stanford University from 1940 until 1953. Polya wrote *How to Solve It,* one of the most widely distributed mathematics books in history. The popular book has sold more than one million copies and has been translated into 15 languages. Polya made notable discoveries in probability, problem solving, geometry, numbers theory, and other fields, and his name is associated with several mathematical concepts. His 1925 book *Problems and Theories in Analysis,* which he wrote with Gabor Szego, is considered by many to be his most important work. It was written when Polya was working at the Swiss Federal Institute of Technology, where he taught for 26 years. Polya received the Mathematical Association of America's distinguished service award in 1963, for his constructive influence on mathematical education in the widest sense. His other writings include *Mathematics and Plausible Reasoning, Mathematical Discovery,* and *Mathematical Methods in Science.*

Source: Biography Resource Center, University of Central Florida, retrieved July 27, 2004.

translating language into mathematical symbols and establishing equations are used. When examining social problems, the procedures might involve collecting data in the form of written materials, newspaper reports, television documentaries, and personal interviews. Literary dilemmas might require a systematic analysis of the meaning of words and phrases used in the literary selection, particularly in a genre such as poetry. Because devising a plan is directly related to the subject matter at hand, it is imperative that you, the teacher, help your students to develop the necessary skills to do this effectively. According to Word, Woloshyn, and Willoughby (1995), this takes direct instruction and time.

Once the plan is designed, students must carry it out and reexamine what they have done. In the reexamination stage, they need to think about the effectiveness and efficiency of their plan. If they were going to solve a similar problem in the future, what would they do differently and why? This last stage is very important in helping students to build their skills and confidence in problem solving. They also need to learn that finding a solution that *does not work* is just as important to their learning as finding one that does work. Much of our progress in science has been based on learning about what did not work.

Decision Making

Our lives are filled with decisions: what to eat for breakfast, what to wear on any given day, what books to read or television programs to watch, what movie to see, what classes to take, what car to buy, what college to go to, what job to accept, what insurance to buy, what house to buy, where to live, and so on. Some of the decisions we make almost automatically—for example, what to eat for breakfast. Rarely do we debate the alternatives and decide which is the healthiest or most economical. We eat either what we always eat for breakfast, what we can grab on the run, or all

TABLE 12.1 Decision-Making Model

Define the decision-making context:

- Identify the goal or purpose to achieve
- Identify values
- Understand uncertainty
- Identify alternatives
- Analyze alternatives
- Rank alternatives
- Evaluate alternatives
- Choose the best alternative

too often, nothing at all. This type of decision making is more of a habit than a thoughtful, deliberative process of sensible, objective, and rational examination of viable alternatives. What we are going to examine here is the latter form of decision making: having to choose among alternatives when we are faced with decisions that may have more complex outcomes.

There are a variety of models of decision making; the one presented in Table 12.1 combines the decision making models of Barry Beyer (1987) and Robin Gregory and Robert Clemen (2004).

In defining the context for decision making, it is imperative that you learn when to use a systematic process for decision making, that is, does the goal or purpose to be achieved warrant the time spent on following a systematic decision-making process? Not every decision you make requires this process. For example, there is no need to use this process to decide what you are going to wear or what you are going to have for dinner, but the process may be very important when you are buying a car, deciding which college to attend, or weighing job opportunities. Being able to clearly delineate the goal or purpose to be achieved is important because the desired goal or purpose becomes a criterion for judging the available alternatives. By defining your goal or purpose, you will examine the gap between your goal and your current situation and attempt to identify causes for that gap and means of closing the gap (Kysilka & Biraimah, 1992).

Decisions are not made in a vacuum; they are highly affected by the values that you hold, whether those values are societal or personal. When making decisions, the alternatives you think about lead to different consequences, some of which may be more satisfying to you than others, depending on the values that you hold. Thus, understanding your values is an important but often neglected part of learning how to make good decisions. When making decisions within a group setting, individual values and beliefs may be part of the reason that some groups have difficulty making decisions—their values may be in conflict. Knowing and understanding your values requires you to be introspective, to think carefully about what is really important to you and what pleases you the most. When you understand your values, you become more conscious of the values of others and begin to appreciate the different opinions that exist in a group. Understanding your values also empowers you to make better decisions (Gregory & Clemen, 2004).

Our lives are filled with uncertainty. Whether that uncertainty relates to the price of gasoline from week to week whether your lost luggage from your recent holiday trip will ever be found and returned to you, or what the weather will be tomorrow, it can influence the decisions we make. Suppose, for example, that you are planning a road trip to North Carolina. Based on

the number of days and the distance you have to cover, you estimate the cost of gasoline as part of your decision to make the trip. However, two days into your trip, the cost of gasoline escalates from $2.25 a gallon to $2.37 a gallon, and then, before your trip ends, to $2.86 a gallon. Was your decision to take the trip flawed? Not really—you had no way of knowing that the cost of gasoline would skyrocket during your trip. It was simply an uncertainty that you had little control over. The key to dealing with uncertainties is to identify them, get as much information about them as possible if you think they will have a negative impact on your decisions, then proceed with your decision-making process.

Identifying feasible alternatives to achieve your goal or purpose is a very important step in the decision-making process. Ways to determine alternatives include brainstorming, the use of analogous or similar case options, or the elaboration of possible alternatives.

Once you have a set of alternatives, you need to analyze them. The analysis should be based on relevant criteria. Those criteria are directly related to the goal or purpose you are examining, but most often include long-term and short-term consequences such as the costs (financial or opportunity) and resources needed for each of the alternatives (Kysilka & Biraimah, 1992).

The sixth step in this process is ranking the alternatives. Because the alternatives have been analyzed according to criteria, the ranking will be determined by how well they meet the criteria.

The next step is the evaluation of alternatives, which requires you to think about trade-offs (Gregory & Clemen, 2004). Dealing with trade-offs is a very difficult task: It means examining values in light of consequences and weighing equally viable alternatives with different consequences—maybe positive immediate results but not-so-positive long-term results. You need to ask yourself, what is most important as you attempt to rank your alternatives: knowing that you may be giving up immediate wants for long-term gains or vice versa.

The final step in this process is choosing the best alternative. Your final selection will be based on your best efforts to analyze, rank, and evaluate your alternatives. Once you have selected the alternative and put it into operation, you will experience the consequences of your decision making. Afterward, you may want to reflect on your decision to assure yourself that you made a good decision or reexamine what you did and what you might want to do differently if the consequences were not what you expected.

Obviously, decision making is not an easy task, but because you engage in so many decision-making activities in the course of a day, most of which require no in-depth thinking, you may not consider this an important skill to teach to your students. However, when teachers are asked about the thinking skills that students need, decision making is among the first that they mention, mainly because poor decision-making skills can affect students in all walks of life (Beyer, 1987).

Critical Thinking

Critical thinking can be defined as "reasonable and reflective thinking which uses a variety of skills to reach logical, unbiased and informed reasons or conclusions" (Kysilka & Biraimah, 1992, p. 119). This definition attempts to encompass the important aspects of critical thinking as defined by writers in the field of thinking skills. The skills required for critical thinking are reactive, that is, they are used to judge the acceptability of the opinions, conclusions, or responses you might have to a given situation. Critical thinking, then evaluates your own or another person's perceptions of reality. Like other thinking skills, critical thinking may manifest itself

differently in different contexts and subject areas: In mathematics, deductive reasoning is very acceptable, whereas science generally prefers inductive strategies. Social studies uses cause and effect and informal reasoning to determine truth and falsities, and language arts may use language or character analysis to determine meaning in a piece of literature.

According to Robert Ennis (1991, 2000a), critical thinking involves both dispositions and abilities. He defines dispositions as characteristics of the thinker, such as the following:

- Caring about the truth and being willing to justify one's decisions
- Being well informed
- Considering other points of view
- Remaining open minded
- Maintaining a focus on the question
- Seeking and offering reasons
- Taking into account the total situation
- Caring about the dignity and worth of every person
- Avoiding intimidating and confusing others
- Being concerned about others' welfare

Ennis defines abilities as skills of thinking, such as the following:

- Identifying and formulating questions
- Formulating criteria for judging answers
- Identifying stated and unstated reasons
- Seeing similarities and differences
- Summarizing
- Asking and answering questions of clarification—why, what, how?
- Judging the credibility of a source
- Drawing inferences—deducing and judging deductions and inducing and judging inductions
- Explaining conclusions
- Making and judging value judgments
- Defining terms, judging definitions, identifying and handling equivocation (the context in which the language is used)
- Identifying assumptions

Ennis believes that a good critical thinker is disposed to get it right and to "present a position honestly and clearly, and to care about the worth and dignity of every person; furthermore the ideal critical thinker has the ability to clarify, to seek and judge well the basis for a view, to infer wisely from the basis, to imaginatively suppose and integrate, and to do these things with dispatch, sensitivity, and rhetorical skill" (2000a, p. 7).

Educator Biography

Robert Ennis was a high school teacher in Fithian, Illinois, from 1951–54. Later, he was an instructor in the philosophy of education at Cornell University and a professor of philosophy at the University of Illinois–Champaign. His books include *Language and Concepts in Education* (1961), *Critical Thinking Readiness in Grades 1–12 (Phase I: Deductive Reasoning in Adolescence, Logic in Teaching,* 1969), *Ordinary Logic* (1969), and *Critical Thinking* (1996).

Source: Biography Resource Center, University of Central Florida, retrieved July 27, 2004.

As you examine Ennis's abilities, you will recognize the relationship of these statements to Bloom's revised taxonomy; both ask students to function at the higher cognitive levels of the taxonomy—application, analysis, evaluation, and synthesis.

Richard Paul and Linda Elder (2004) of the Foundation for Critical Thinking have indicated that students must master two elements of critical thinking: the identification of the "parts" of their thinking and the assessment of their use of these parts. The parts of thinking are as follows:

- All reasoning has a purpose.
- All reasoning attempts to figure something out.
- All reasoning is based on assumptions.
- All reasoning is based on information.
- All reasoning is dependent on concepts and ideas.
- All reasoning involves inferences used to draw conclusions.
- All reasoning leads somewhere and contains implications and consequences.

The assessment of these parts might depend on the context in which the thinking occurs, but generally it can be evaluated through assessment standards of clarity, precision, accuracy, relevance, depth, breadth, and logic. The quality of students' critical thinking is dependent on how they apply the standards of assessment to their elements of thinking.

As you can see, critical thinking is a complex activity, and no one teaching strategy can possibly help students to learn all the aspects of critical thinking. Thus, it is imperative that as a classroom teacher, you recognize when, where, and how you can include critical thinking in your teaching strategies. Because critical thinking functions differently according to context, you need to be aware of how a specific content area or topic addresses critical-thinking skills. Ennis (2000b) has provided some suggestions for the teaching of critical thinking skills:

- Always encourage your students to think about alternatives (hypotheses, conclusions, points of view, plans, and explanations).
- Emphasize the use of evidence and searching for reasons—why is an important question.
- Emphasize the importance of keeping an open mind.

- Engage students in asking questions and discussion—use controversial situations to encourage participation.
- Provide students with time to think.
- Encourage students to verify each other's answers and positions.
- Have students read each other's ideas and suggestions.
- Provide criteria for judging written position papers or have students develop the criteria that you will use.

An important concept to remember is that, although you interact with students, you should model critical-thinking skills. Modeling is a strong strategy to encourage students to participate in critical-thinking activities. If they see you thinking critically, they will be more likely to engage in critical thinking. At least they will know that the environment is safe for them to try.

Creative Thinking

What is creativity? This is a very complex question. There are numerous definitions of creativity, and they change constantly as we learn more about how the brain functions. There seems to be agreement that creativity is a combination of three factors: ability, attitude, and processing skills. We also know that creativity is something that can be measured on a continuum: There are degrees of creativity, and some people may be more creative at times than others depending on the context in which they are using their creative skills. Some students can be highly creative in the language arts but not in mathematics or history. Some students demonstrate

The information-processing skills of creative students are different from those of other students.

outstanding creative skills in art but not in science. Some students excel is creative thinking in science but not in music. We also know that some individuals have something that we might define as "general creativity"—that is, they seem to function creatively in a variety of contexts. If we look at the abilities of creative individuals, we might describe them as

- intrinsically motivated
- able to easily synthesize ideas
- able to exhibit original thought
- unorthodox in their thinking
- able to go beyond the obvious
- very imaginative
- able to see multiple perspectives easily
- flexible with ideas
- nonjudgmental
- inventive
- elaborative

These abilities (Kysilka & Biraimah, 1992) indicate characteristics that often get students into trouble in some classrooms but allow them to excel in others. For instance, some teachers might find unorthodox thinking problematic in their classrooms, particularly if the class is mathematics or maybe history; however, the ability to synthesize information and see multiple perspectives may prove to be a positive characteristic in the language arts, and having flexible ideas and nonjudgmental skills may prove to be positive traits in a science classroom. Just knowing about the abilities of students is not enough. How these abilities interact with student attitudes has much to do with the way these students are perceived by their teachers. Creative individuals often

- take risks
- are not inhibited by convention, tradition, or reality
- like to toy with ideas
- break rules
- challenge authority
- push boundaries
- break boundaries
- prefer to work alone

As you look at these attitudes, you can imagine the challenges these students create for some teachers. Students who challenge authority or push boundaries may frustrate many teachers, particularly less experienced teachers. Students who break rules and care little about convention or tradition often create havoc in a classroom. A risk taker with strong unorthodox

thinking who is working alone on a project may create a project that is highly questionable as to its appropriateness for the classroom. Thus, when working with these students, you may find that you need to monitor them a little more closely than you had anticipated.

The information-processing skills of creative students are often quite different from the processing skills of other students (Kysilka & Biraimah, 1992). Creative students think

- divergently
- metaphorically
- analogically
- cyclically, reexamining ideas again and again
- analytically, examining experiences to satisfy their need to learn from them
- objectively and subjectively
- aesthetically, seeking to order, categorize, or rearrange ideas until they are aesthetically satisfying

These students frequently work at the edge of their competence, tolerate confusion and uncertainty, and are willing to accept a higher risk of failure than many other students (Perkins, 1991). Schools and the way classes are structured often work against creative thinking. This is particularly true in the current environment of high-stakes testing. Because teachers are expected to ensure that students excel on the high-stakes tests, they find little time to explore the aesthetic nature of their subject—for example, few teachers help students to see the beauty of the structure of mathematics because they are too busy getting students to compute. Little time is spent understanding the nature of history as a synthesis of hundreds of pieces of data; students are too busy memorizing the data. Even in science classes, time spent in the laboratory discovering scientific concepts is often replaced by students being told the concepts. And because of heavy teaching loads, many language arts teachers forgo writing-process philosophy for less labor-intensive grading activities.

Forty years ago, E. Paul Torrance (1966) described four aspects of creative thinking that can be incorporated into your teaching with relatively little effort and can enhance and encourage the creative thinking of your students:

- *Flexibility* refers to establishing points of view or developing multiple perspectives to a problem. Students can learn to be more flexible if you use strategies that encourage this—for example, asking students to redefine a problem, paraphrase an idea, or engage in forced associations. When you use forced associations, you give students two very different objects, such as a brick and a car, and ask them to determine how they are alike. By having to look beyond the objects and think about how they are used, students may come up with similarities they would never have thought about before. Once they get used to this type of "stretching the mind," they can use what they have learned as they approach other problems. How many times have you, when building a puzzle, walked around the puzzle or turned the puzzle to see how a piece might fit? How many times have you looked at a diagram and found yourself moving the paper around to get a different image? These are tactics for developing different perspectives or points of view—tactics that indicate your flexibility of thought.

- *Fluency* is defined as the ability to supply a variety of responses. You can encourage your students by directly asking them, how many different ways can we solve this problem? Or you might ask, how many invertebrates can you name? Or, how many different words can you think of that describe the color blue? Students need to be encouraged to offer multiple answers, not just one. Brainstorming techniques can help students to become more fluent. Fluency can be learned. Fluent thinkers are better at drawing conclusions and making generalizations than who are less fluent.

- *Elaboration* is defined as the ability to embellish ideas and add detail. As we have indicated, elaboration is a characteristic of creative thinkers and can be taught. Again, you need to help students to develop this ability. In the primary grades, you can help students to develop their elaboration skills by giving them a picture that they are asked to enhance. The directions you may give them can be as simple as, "Take this picture of a house and make it look different. You can add objects to the picture, such as people or animals, change colors, or put in details that aren't there, such as putting lines on the roof to indicate shingles. Make this picture uniquely yours." Or as the children are reading, you might ask them to draw pictures about what they are reading. In secondary classrooms, you can ask students to elaborate on each other's ideas. For example, Bob made a statement in an economics class that the cost of gasoline has gone up because of the war in Iraq. You might then ask Tenitia, "Tenitia, can you explain Bob's idea about how the war in Iraq has caused our gasoline prices to go up?" Tenitia replies. "That's good Tenitia, Rae, can you add anything to Tenetia's explanation?" If you are teaching language arts and are engaged in writing activities, you might encourage students to add adjectives or adverbs to their sentences to enhance their message. Helping students to improve their elaboration skills is not hard to do.

- *Originality* is the ability to create unique ideas. You really cannot teach originality, but what you can foster the original thinking that your students already have. Too often, students do not recognize that they have any original thought. You need to let them explore their originality. One activity that has always worked with students, regardless of age, is to give the students a paper plate, a glob of clay, and some toothpicks and ask them to make a sculpture. You will be amazed, as will they, by the different pieces of sculpture they create. There is no right or wrong to their creations. Another activity that can help students to recognize their original thinking is to give them a picture book and then ask them to write a story. What you want to do is convince your students that everyone has original thought; some may have more or more complex thoughts, but everyone is capable of creating ideas—they simply need the opportunities to do so.

As you can see, creative thinking is multidimensional and rather complex. It is both aesthetic and practical; it involves skills found in problem solving, decision making, and critical thinking; it requires students to work "outside the box"; it can be fun for some students and highly threatening for others; and it can be enhanced by helping students to understand some of the basic aspects of thinking creatively. As a teacher, you may find that the most challenging students you will ever work with are the highly creative ones; they are more likely to rebel against traditional teaching strategies than other students. Creative thinkers are explorers and questioners, and they want opportunities to do these kinds of activities in school. When such opportunities are not available, they become very frustrated and either disrupt classes or simply shut down. Some have learned how to tolerate school, but they do not necessarily live up to their

TABLE 12.2 Differences in Critical and Creative Thinking

Critical Thinking	*Creative Thinking*
Analytic	Generative
Convergent	Divergent
Vertical	Horizontal (lateral)
Probability	Possibility
Judgmental	Non-judgmental
Focused	Diffused
Objective	Objective and subjective
Left-brained	Right-brained
Verbal	Verbal and visual
Linear	Associative and circular
Reasoned	Novel

potential. You have an obligation to help these students get the most out of their time in school and maximize their potential for learning.

Robert Harris (1998) has provided a comparison of critical and creative thinking and indicated how both types of thinking are important to problem-solving and decision-making skills. The table is presented here with some slight modifications by the authors (see Table 12.2).

Edward de Bono developed a system of "six thinking hats," which is a quick, simple technique to help you improve and organize your thinking. His system identifies six "hats" that require you to consider the kind of thinking you are engaged in at any given time. As you are working on a problem, you "place" one of the hats on your head to determine what kind of thinking you are using or need to use. The six hats are as follows:

- The *white hat* calls for information known or needed. This involved data gathering and objective thinking.
- The *red hat* signifies feelings, hunches, emotions, and intuition. The red hat allows the thinker to use feelings and intuition without having to justify his or her thoughts.
- The *black hat* is used for judgment and caution. It is a very valuable hat. The purpose of black-hat thinking is to point out why suggestions might not be appropriate for the situation. This is the logic hat.
- The *yellow hat* symbolizes brightness and optimism. It is positive, logical thinking. This hat allows you to determine what will work and why it will offer benefits.
- The *green hat* focuses on creativity.
- The *blue hat* is used to manage the thinking processes. This is the metacognitive hat.

Using the six hats thinking process can help you to manage the types of thinking you need to engage in. It is an effective tool to help your students begin to recognize the kinds of thinking they are engaged in or need to solve a particular problem or situation.

CLASSROOM SCENARIO

The teachers at Seneca High School have just returned from a districtwide meeting at which the superintendent of schools indicated to them that, although he was pleased with their progress in improving students' scores on the exit exams required by the district at each academic level (elementary, middle school, and high school), he was very concerned that the National Assessment for Educational Progress reports revealed that the higher-order thinking skills of the students at each of these levels have not improved. The district has decided, therefore, to include higher-order thinking skills questions on future exit exams and expects teachers to do a better job of teaching these skills in their classrooms. The teachers are all abuzz about having to do more in their already packed curriculum and indicate that they think the superintendent is asking them to do too much—there is no time to add thinking-skills instruction to their curricula.

Mrs. Pack, the principal, Mr. Jelicek, the assistant principal of instruction, and Miss Hernandez, the curriculum coordinator, decided that teachers needed time to talk about these new challenges and to decide how they will meet the expectations of the district. They organized a two-day retreat to tackle the problem. The retreat was held at a nearby state park that had lodging facilities, recreational activities, and great food service. Teachers were encouraged to bring families along to enjoy the park's facilities while the teachers engaged in academic conversations. Over 80% of the teachers came to the retreat. The principal used staff development monies to pay for the retreat and only asked the teachers to pay extra for their spouses, significant others, and children.

At the retreat, teachers initially grouped themselves into subject areas and identified the higher-order thinking strategies they were already teaching. They used Bloom's revised taxonomy to help them classify the thinking strategies. What they discovered was that within their subject areas, they were already teaching most of the skills that would be included on the new tests. They also determined that they needed to help the students recognize that they were using these skills by placing more emphasis on metacognitive strategies—making the students aware of their thinking. Even though this was a great discovery for the teachers, they were still concerned that knowing this and emphasizing the skills within their content areas might not be enough to see improvement in thinking skills on a test.

Consequently, on the second day of the retreat, the teachers broke into different teams—this time, they were interdisciplinary. They wanted to know whether the thinking skills they were using in their subject areas were similar to or different from those used in other content areas. It did not take the teachers long to determine that the skills overlapped. The problem then, became how to capitalize on the fact that the skills were overlapping between content areas.

The teachers began to look at which skills were present in the curriculum. They found that mathematics and science used problem-solving and decision-making skills in all of the various subjects in these fields. They also realized that critical-thinking skills were part of the process of problem solving and decision making. The mathematics and science teachers started to plan how they could emphasize the interrelationship of these skills in their subject areas. The language arts and social studies teachers said that these skills were also used in their subject areas, although they tended to focus more on inquiry, critical thinking, and creative thinking. The art, music, and drama teachers thought they could help in the areas of critical and creative thinking. The industrial arts teachers thought that decision-making and problem-solving skills were used extensively in their curriculum. The physical education teachers said that decision making and creative thinking were also part of their curriculum.

CLASSROOM SCENARIO (Continued)

As the discussions extended into the afternoon, the teachers decided that, collectively, they were teaching a variety of thinking skills, but the impact was lost on the students because there was no coordination within the curriculum to help students realize that thinking skills span the curriculum and that what they learn in one setting could be applied to another. Too much time was wasted teaching and reteaching skills that students technically already new.

The teachers decided they needed to get a curriculum planning task force together that could examine all the suggestions from the teachers and design a plan for the incorporation and emphasis of higher-order thinking skills across the curriculum. They determined that through multiple subject areas and multiple perspectives, students would realize that thinking skills are used everywhere, all the time, and that these are essential survival skills. They also did not want one group of teachers to be held responsible for teaching these skills when it was evident that they were used in every subject area. They charged the task force with the following responsibilities:

- Synthesize the data on higher-order thinking skills and how they are taught in the various subject areas.
- Find areas within the curriculum that use similar skills at the same grade level—for example, problem solving in ninth-grade general mathematics, ninth-grade environmental science, ninth-grade social studies, and ninth-grade English.
- Where similar skills are used at the same grade level, have team members from these subject areas get together to determine how they can collaborate to ensure that students understand the thinking skills and see how they are used in the various subject areas.
- Determine whether any thinking skills that are deemed essential are not being taught in the curriculum or are relegated to a single subject area. If this is the case, provide suggestions on how these skills can be incorporated into the curriculum.
- Develop a set of generic guidelines that will help existing and new teachers to see where in their content areas different thinking skills are taught, how to coordinate teachers' efforts in teaching the skills among the different content areas, and how to emphasize the skills while students are using them.
- Create a series of activities that teachers can use to help students understand their metacognitive strategies.
- Complete the report and have it ready for teachers to read and revise by the next schoolwide retreat in four months.

The concern of the faculty was that the problem could not be resolved by the large group, but by putting together a task force, they were more likely to begin to make progress in planning for the teaching of thinking skills. What the teachers understood throughout the retreat was that they were already using higher-order thinking in their classrooms, but there was no specific emphasis on the skills or any attempt to coordinate their work with each other. They also realized that they did not have time to include a special course in thinking skills, so integrating them into the existing curriculum, where they are used anyway, was the most appropriate strategy.

The teachers recognized that they were teaching at the higher cognitive levels, but their efforts were frequently lost on the students, who knew that what counted was getting the correct answers on the multiple-choice exit exams, which required little higher-order thinking. And, students being the astute people that they are, they preferred to spend their time memorizing information they knew they would be tested on rather than thinking about that information and how it might be

CLASSROOM SCENARIO (Continued)

useful to them in the future. The teachers were determined to change the students' perspectives about what learning was all about, and they believed their plan was the beginning of restructuring their curriculum so that the students would learn how to learn and, in the process, improve both their lower- and higher-order thinking skills.

The teachers were excited about the prospect of getting help from each other on accomplishing a task they thought was important and would help them to do a better job of teaching for learning in their classrooms. All the teachers were willing to help members of the task force and were enthusiastic about having another retreat.

ASSESSMENT

Inherent in the use of higher-order thinking is assessment. As you engage students in higher-order thinking skills, you will be able to easily assess their use of these skills in the activities you plan. For example, if you are doing problem solving and students cannot find a suitable solution to the problem, you can use selective questioning to find out where their thinking went astray. More often than not, when viable solutions do not materialize, it is because the students did not have a clear definition of the problem.

If you ask the students to do a critical analysis of a piece of literature, you can determine from their responses whether they were able to do so successfully. But you might not want to wait until the students have engaged in a complex thinking process before you know whether their thinking is on track. To help the students, particularly as they are just beginning the process of systematic thinking, you might want to create a story guide that they can follow to keep them on track. This guide does not have to be dictatorial, but a means of helping them to focus on the processes they should be using to complete the task. For example, you might want the students to pay specific attention to the following ideas:

- Plot: What is the definition of a plot? How is it developed? Who are the most important people to think about in the development of the plot?
- Characters: Who are the characters? How are they related to each other? Which characters are most important to the story? Which characters provide an interesting diversion in the story? Are there any characters whose presence is not essential to the story?
- Story line: How is the plot established at the beginning of the story? What pieces of information are most important to remember as you progress through the story? As you became involved in the story, did you see the plot changing? If so, how? How did the characters' roles change as the story progressed? Was the ending of the story what you had expected? How did you think the story would end? Why do you believe the author chose to end the story the way he or she did? Do you think the ending was plausible?
- Evaluation: Based on your analysis, how would you rate this story? Do you think it had a message for the reader? If so, what was it? Was the story for pure entertainment, not focused on providing a specific message? Does all literature have to have a message? Would you recommend this story to one of your parents, a sibling, or a best friend? Why or why not?

If the students know ahead of time what they are expected to do in an analysis of a piece of literature, they will pay more attention to what they are reading and will not have to retrace their steps to answer questions. Remember, part of your responsibility in getting students to think at higher levels of cognition is to guide them to those levels. They will not automatically think at those levels; rather, they must be taught to do so through systematic processes.

You can also assess students' higher-order thinking skills through the tests that you administer to them. Unfortunately, most tests, whether they are standardized or teacher constructed, focus on lower rather than higher levels of thinking. It is much easier to construct factual, knowledge-based questions than thoughtful, higher-order questions. Lower-level questions are by far easier to grade—they are right or wrong, no in between. Higher-order questions that are not of the multiple-choice variety (yes, it is possible to construct multiple-choice items that measure higher-order thinking) are open to much more subjective analysis, particularly if the questions are not well phrased and do not clearly delineate what is expected. Subjective responses are open to many interpretations, and often students' intents and teachers' understandings are not the same.

Although testing for higher-order thinking is not easy, you should begin to think about incorporating higher-order thinking questions into your examinations. You might want to read up on how to become not only an effective test constructor but also a good assessor of learning by reading James Popham's book *Classroom Assessment: What Teachers Need to Know* (1999).

TECHNOLOGY

No discussion of thinking skills can occur without thinking about how those skills can be enhanced through the use of technology. Typically, in most schools today, technology in many classrooms is relegated to review processes, remediation, or maybe curriculum enhancement. Even in the last-named use, however, students are frequently on their own to surf the Web to find the information teachers want they to use to provide depth to their understanding of a concept. Thus, students, search, read, and respond. Although this is not a bad use of technology, it certainly does not use technology efficiently to help students develop higher-order thinking skills.

Much of the rhetoric in curriculum areas refers to authentic learning and authentic assessment. In this context, writers indicate how the use of the World Wide Web can provide the students with tools for authentic learning—real artifacts, access to expert knowledge, and interactive engagement with information. What does this mean? If you are teaching an art class, you can have students take a virtual tour of a number of major art museums around the world. In these virtual tours, students can not only view classic pieces of art but also access information from experts who discuss the artist and the history of the particular piece, get a critique about the piece, learn the monetary value of the piece of art, etc. In a social studies class, you can access original documents such the U.S. Constitution, Bill of Rights, or Declaration of Independence. You can find original newspaper articles that describe major historical events, such as man's first walk on the moon. You can engage interactive science sites that help students understand the basic principles of electricity.

The point is technology has put more information, more accurate data, and more interesting concepts at your fingertips. History no longer needs to be boring, science can be exciting and exploratory, art can be awesome, mathematics can be understandable, music can be

inspiring, and literature can be engaging. The technology is available to make all of this happen. It can make learning more realistic and more authentic.

According to many writers in the field of computer literacy, "the WWW [used] in a learner-centered, authentic, problem-based, and collaborative environment can lead to the development of complex thinking skills" (Bradshaw, Bishop, Gens, Miller, & Rogers, 2002, p. 280). Technology—specifically, the computer and the Internet—can help students to connect the different kinds of knowledge they are exposed to into a coherent whole much easier than their teachers can. With a click of the mouse, students can find answers to complex questions, solutions to problems, questions to ponder, ideas to explore, projects to do, and, yes, games to play. The point is that students have access to lots of information that changes on a daily basis. They need to be able to harness that information in positive ways through the use of complex thinking skills, such as finding, retrieving, categorizing, analyzing, evaluating, and synthesizing information.

What does this mean to you? You need to become familiar with what is available on the Web that is appropriate for your subject area. Not only are you looking for sites within your subject area, but also you might want to explore sites that will help you to design activities for your classroom. One such site is the WebQuest Page (http://webquest.org). On this website, Bernie Dodge of San Diego State University defines a WebQuest as in inquiry activity in which the information the students use is derived partly or totally from the Internet. Short-term WebQuests (two or three days) are designed for knowledge acquisition and integration, and long-term WebQuests (one week-one month) are designed to extend and refine knowledge. Together, these two activities engage learners in all levels of higher-order thinking. The website provides you with guidelines to set up an effective WebQuest.

You need to know whether the textbooks you use have accompanying CDs with appropriate lessons that focus on higher-order thinking skills. Most textbooks include CDs that not only include material for remediation and review, but also activities and projects that enrich students' learning by providing them more depth or breadth to their understanding of the content. The CDs may also provide self-check activities that can help students monitor their own learning.

You need to become comfortable using technology in your classroom. If you are a current student in a teacher-preparation program, chances are you are getting much instruction in using and incorporating technology into your classroom teaching. If, on the other hand, you graduated a while ago and are now finding yourself in a teaching situation, you may not have had much experience using technology as a learning tool and certainly not as a teaching tool. Therefore, you might want to access any and every opportunity provided to you through your school or district to become knowledgeable about using technology. You can also become an explorer of the Internet and find your own sites for use in knowledge acquisition. Most college and university libraries have access to a variety of databases that can provide you with information about how to integrate technology into your classroom. You can find specific lessons on how to teach each of the thinking strategies described in this chapter. The information is endless.

You need to communicate with your colleagues. Most good ideas that teachers use in their classrooms come from their colleagues. Start talking to your peers. Find out whether they are using technology and how. Ask them for resources. Ask them what works and does not work. Ask them how you can use technology effectively if you only have one or two computers in your room and your class size or smallest class is 25 students. Go to the curriculum resource person in your school (sometimes that person is your librarian or media specialist) and ask him or her for help. These individuals are trained to be a resource for you.

Be a risk taker. Don't be afraid to use the technology available to you. You might start simply. For example, start using the overhead projector instead of the chalkboard. It is much easier to list ideas in a brainstorming situation if you can keep your eyes on your students rather than your back to them while you write on the board. Introduce films, videos, or CDs in your classroom and structure your debriefing of these around higher-order questions. Give students an assignment that asks them to find a specific site on the Internet and give them a learner's guide (a series of questions they need to answer) to use as they work through the site, asking questions at all levels of Bloom's revised taxonomy. Many students may have computers at home, others will not. So be certain that if you use such an activity, you provide ample time for those students who must use school computers to get the assignment done.

Learning Tenets That Support Thinking Patterns

All of the Learning Tenets that we believe in are appropriate as you incorporate higher-order thinking skills into your classroom teaching.

The brain seeks to classify information and the things to be learned

As you think back to what you have learned about higher-order thinking, you will realize that this type of thinking asks students to classify and categorize information. You cannot get far in higher-order thinking if you cannot bring sense to the information you are receiving, and bringing sense means placing information into categories already in existence or creating new categories.

The emotional system drives attention, and attention drives meaning and memory

When you are engaged in higher-order thinking, you become emotional about what you are saying, doing, and thinking. One of the reasons that de Bono's six thinking hats are so popular is that he recognizes the role of emotion in the thinking process and specifically calls attention to the fact that as you engage in complex thinking, you cannot remove emotion from your actions. You may get angry, frustrated, tired, intolerant, excited, perplexed, or satisfied during your activities. Each of these emotions creates a different action and a different memory of what happened. Most of you can remember an "aha!" moment when you finally caught on to something that had been perplexing you, and you never forgot what you learned. You can also remember when you were so frustrated that no clear thinking could occur, and you clearly remember what you did not learn. Sometimes that experience creates interference in your thinking when you confront that content again. Interference can eventually translate into a fear of learning something.

Learning occurs in both conscious and unconscious states

Although the intent of higher-order thinking is to engage students consciously in their learning, the nature of the problems or situations that you ask students to engage in can have a residual effect. Have you ever worked on a problem for awhile, did not find a satisfactory solution, put it aside, and did something totally different? Then, maybe even a day or two later, out of the clear blue sky, the solution hit you. What this suggests is that you never put the problem out of your mind. You simply did not pursue direct thinking about it, yet your mind kept playing with the idea and then, bingo—solution! What this tells you as a teacher is that you need to provide adequate time for students to engage in higher-order thinking skills. Problem solving, critical thinking, creative thinking, and decision making do not always work on a specified time schedule. Granted, you cannot always give as much time to the activity as it needs, but do not assume that if students do not find an effective or plausible answer, they can not think—they may need more time.

The brain is designed for ups and down, not constant attention

Higher-order thinking is a very complex and intensive activity. Sometimes you can think creatively or critically for long periods of time and then simply shut down. In this circumstance,

your brain is saying, "I can't process any more." The best thing to do under this condition is to find an alternative activity to engage in, one that is not so intense. Give your brain a rest. Once you are refreshed, your thinking may easily get back on target.

Learning occurs through processing and active engagement with visual, auditory, and kinesthetic modalities

As you think back to the various strategies discussed in this chapter, you will realize that higher-order thinking is precisely what this tenet is all about. You cannot think at higher cognitive levels without being actively engaged with your visual, auditory and kinesthetic modalities.

Good teaching is about recognizing and selecting instructional patterns that match the context for learning and the students we are teaching

Good teaching includes teaching students to think, and to get students to think critically and creatively and to positively engage in problem-solving skills and systematic decision making, you must help them learn these skills and apply them appropriately to their life situations. Strong thinking skills will help any student succeed in life. Every student can learn how to think. Some will do it better than others, but all students need to have the opportunity to develop their potential for thinking, just as they need to maximize their potential for learning—the two go hand in hand.

Summary

Thinking skills are best suited to Part VI, "Thinking and Organizing the Content." In this chapter, we reviewed the research on why it is necessary to learn thinking skills. The primary reason for doing so is the diverse society in which we live, where simple solutions are no longer viable responses to the complex problems we face. In defining thinking skills, we revealed how many different definitions exist and how they are all intertwined and intermingled. We specifically addressed teaching for, of, and about thinking skills and focused on four categories of thinking that seem to encompass the multiple definitions of thinking skills: problem solving, decision making, critical thinking, and creative thinking. We provided suggestions on how today's technology can enhance the learning of thinking skills and provided information on how assessment of thinking skills is an integral part of the development of the skills themselves.

Thought to Action

1. Make a list of the kinds of questions you would like to ask your students as they engage in each of the four categories of thinking skills: problem solving, decision making, critical thinking, and creative thinking. Once you have these lists developed, look to see whether you listed similar questions for each category. How can you use this knowledge as you think about incorporating thinking skills into your content area?
2. Examine the curriculum materials you will be using in your classroom. Pay specific attention to the end-of-the-chapter activities. How are these activities related to the teaching of thinking skills in your content area?
3. Design a unit that you are going to teach. In that unit, specifically plan to incorporate higher-order thinking skills. Which skills will you incorporate? Why? How do they relate specifically to the content you are planning to teach? How will you assess the students' use of those skills?
4. Using the Internet, find examples of assessments for student thinking in your content area. What strategies are suggested? Confer with a colleague in a different subject field. What similarities do you find? If you work together as a team, how could you help each other to teach these skills?
5. Form a small discussion group. Talk to each other about the impact of the No Child Left Behind legislation and how it is enhancing or inhibiting the teachers' ability to teach higher-order thinking skills in the classroom.