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HIGHER ORDER THINKING SKILLS

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Higher order thinking skills include critical, logical, reflective, metacognitive, and creative thinking. They are activated when individuals encounter unfamiliar problems, uncertainties, questions, or dilemmas. Successful applications of the skills result in explanations, decisions, performances, and products that are valid within the context of available knowledge and experience and that promote continued growth in these and other intellectual skills. Higher order thinking skills are grounded in lower order skills such as discriminations, simple application and analysis, and cognitive strategies and are linked to prior knowledge of subject matter content. Appropriate teaching strategies and learning environments facilitate their growth as do student persistence, self-monitoring, and open-minded, flexible attitudes.

This definition is consistent with current theories related to how higher order thinking skills are learned and developed. Although different theoreticians and researchers use different frameworks to describe higher order skills and how they are acquired, all frameworks are in general agreement concerning the conditions under which they prosper.

Teaching Strategies

Lessons involving higher order thinking skills require particular clarity of communication to reduce ambiguity and confusion and improve student attitudes about thinking tasks. Lesson plans should include modeling of thinking skills, examples of applied thinking, and adaptations for diverse student needs. Scaffolding (giving students support at the beginning of a lesson and gradually requiring students to operate independently) helps students develop higher order learning skills. However, too much or too little support can hinder development.

Useful learning strategies include rehearsal, elaboration, organization, and metacognition. Lessons should be specifically designed to teach specific learning strategies. Direct instruction (teacher-centered presentations of information) should be used sparingly. Presentations should be short (up to five minutes) and coupled with guided practice to teach subskills and knowledge.

Teacher- and/or student-generated questions about dilemmas, novel problems, and novel approaches should elicit answers that have not been learned already.

Sincere feedback providing immediate, specific, and corrective information should inform learners of their progress.

Small group activities such as student discussions, peer tutoring, and cooperative learning can be effective in the development of thinking skills. Activities should involve challenging tasks, teacher encouragement to stay on task, and ongoing feedback about group progress.

Computer-mediated communication and instruction can provide access to remote data sources and allow collaboration with students in other locations. It can be effective in skill building in areas such as verbal analogies, logical thinking, and inductive/deductive reasoning.

Assessment

Valid assessment of higher order thinking skills requires that students be unfamiliar with the questions or tasks they are asked to answer or perform and that they have sufficient prior knowledge to enable them to use their higher order thinking skills in answering questions or performing tasks. Psychological research suggests that skills taught in one domain can generalize to others. Over long periods of time, individuals develop higher order skills (intellectual abilities) that apply to the solutions of a broad spectrum of complex problems.

Three item/task formats are useful in measuring higher order skills: (a) selection, which includes multiple-choice, matching, and rank-order items; (b) generation, which includes short- answer, essay, and performance items or tasks; and (c) explanation, which involves giving reasons for the selection or generation responses.

Classroom teachers recognize the importance of having students develop higher order skills yet often do not assess their students' progress. Several performance-based models are available to assist them in teaching and assessing these skills. Comprehensive statewide assessment of higher order skills is feasible but would be expensive. Florida and a number of other states now

Definition

Major Concepts

Several major concepts relevant to the higher order thinking processes are to follow, based on three assumptions about thinking and learning. First, the levels of thinking cannot be unmeshed from the levels of learning; they involve interdependent, multiple components and levels. Second, whether or not thinking can be learned without subject matter content is only a theoretical point. In real life, students will learn content in both community and school experiences, no matter what theorists conclude, and the concepts and vocabulary they learn in the prior year will help them learn both higher order thinking skills and new content in the coming year. Third, higher order thinking involves a variety of thinking processes applied to complex situations and having multiple variables.

Context

The level of thinking depends upon the context, with a real-world situation offering multiple variables to challenge thinking processes. Going through a cafeteria line and making decisions about types and amounts of food one should eat requires a much more sophisticated thinking process than counting carbohydrates and fats in a classroom (Crowl et al., 1997). Successful higher order thinking depends upon an individual's ability to apply, reorganize, and embellish knowledge in the context of the thinking situation.

Metacognition

The self-correcting nature of thinking is called "metacognition." Metacognition includes awareness of one's thinking processes, self-monitoring, and application of known heuristics and steps for thinking. One's success with metacognition depends, in part, on a belief in one's ability to get smarter as well as the beliefs of others, such as teachers, in one's ability (Crowl et al., 1997).

Procedural Knowledge

Procedural knowledge sometimes is misunderstood as a higher order thinking skill. While it may be a prerequisite for higher order thinking, it actually is a type of knowledge—specifically, knowledge of rules and their application (Crowl et al., 1997). The ability to recite a rule or set of procedures is "information learning"; the ability to apply a rule or procedure to a routine single- variable situation is "application." Neither of these capabilities involves higher order thinking. Instead, applications of procedural knowledge that also involve analysis and synthesis of two or more concepts would be considered higher order thinking. Examples include "constructing map projections and grids, writing clear and concise case reports, calculating the fixed overhead costs for a project, designing spreadsheets, drawing conclusions about the impact of social reform on the universality of social programs, and establishing meaningful relationships with coworkers" (Huot, 1995, p.2).

Comprehension

Comprehension, a part of lower order thinking skills, is integral to higher order thinking skills development. In fact, some research and teaching strategies focus on comprehension as if it were within the higher order domain. While it is an important prerequisite, it is not a higher order thinking skill. Comprehension remains the process by which individuals construct meaning from information and form new "schemata" through specific activities (Crowl et al., 1997), including, but not limited to,

- Generating and answering questions that demand higher order thinking about old and new ideas;
- Confronting conflicting ideas and information, problems, or dilemmas;
- Exploring and making discoveries;
- Conducting systematic inquiries;
- Summarizing, reciting, and discussing new ideas and their relationships;
- Relating new understandings to other concepts;

- Applying new ideas and information in basic problem-solving activities; or
- Reflecting and verbalizing about cognitive processes involved in comprehension.

Creativity

Although some references do not explicitly include creativity as higher order thinking, it cannot be unmeshed from the process. The very act of generating solutions to problems requires the creative process of going beyond previously learned concepts and rules. Creativity involves divergent and convergent thinking to produce new ideas (Crowl et al., 1997). Its place in the network of higher order thinking skills was well articulated in Pasteur's observation that "chance favors only the prepared mind" because "only a trained mind can make connections between unrelated events, recognize meaning in a serendipitous event," and produce a solution that is both novel and suitable (cited in Crowl et al., 1997, pp. 192–193).

Major features of creativity are listed below.

- Creativity involves the consistent use of basic principles or rules in new situations, such as Benjamin Franklin's application of conservation and equilibrium (Crowl et al.,
- 1997); Picasso's creation of "Guernica," resulting from sketches and modifications of previous work; Watson and Crick's discovery of the DNA double helix structure; and Edison's invention of an electric lighting system (Weisberg, 1995).
- Creativity involves discovering and solving problems. Innovative approaches are used to accurately evaluate shortcomings, and actions are taken to remedy those weaknesses (Crowl et al., 1997).
- Creativity involves selecting the relevant aspects of a problem and putting pieces together into a coherent system that integrates the new information with what a person already knows (Sternberg & Davidson, 1995; Crowl et al., 1997). In a basic sense, it involves a series of decision-making choices between "two or more competing alternatives of action," each having "several pros and cons associated with it" (Crowl et al., 1997, p. 169).
- Creativity overlaps with other characteristics, such as "intelligence, academic ability, dependability, adaptiveness, and independence" and can "evolve within each of the seven intelligences" (Crowl et al., 1997, pp. 195–196).
- Creativity requires many of the same conditions for learning as other higher order thinking skills. The learning processes are enhanced by supportive environments and deteriorate with fears, insecurities, and low self-esteem. Creativity deteriorates with extrinsic motivation, restraint on choice, and the pressure of outside evaluation (Crowl et al., 1997).

Insight

Insight is the sudden unexpected solution to a problem (Schooler, Fallshore, & Fiore, 1995). Complexity seems to be the spark for solving problems through insight. Noninsight solutions require using rules, while insight solutions require problem-solving and cognitive strategies as defined by Gagné, Briggs, and Wager (1988). From another perspective, noninsight solutions require comprehension and application, while insight solutions require analysis, synthesis, and evaluation as defined by Bloom (1956). Other research on higher order thinking also applies directly to the concept of insight as follows:

- Insight involves many of the same features as creativity, including examining all factors that could be causing a problem, searching for a new way to state the problem, finding alternative approaches, persevering, taking risks, applying broad knowledge, and recognizing analogies (Schooler et al., 1995).
- Playfulness, creativity, and an ability to unify separate elements are major parts of insight. Causes of impasses include failure to recognize relevant cues or patterns, overemphasis on irrelevant cues, underemphasis of relevant cues, and searches in the wrong spaces (Schooler et al., 1995).
- Dimensions of learning support insight in (1) both pattern recognition and reasoning (Schooler et al., 1995), (2) the second dimension of acquiring and integrating diverse knowledge, (3) the third dimension of extending and refining knowledge through purposefully widened observation and reasoning, (4) the fourth dimension of making choices among alternatives, and especially (5) the fifth dimension of developing productive habits of mind with systematic control of reasoning and scientific methods.
- A study by Beyth-Maron (cited in Cotton, 1997) found that critical thinking underscores the ability to make good choices.
- As with creativity, the "emotional tone of the person solving problems" affects insight (Sternberg & Davidson, 1995, p. xi). Metacognition and cognitive strategies, such as persevering, address the attitudes and habits of mind involved in insight (Gagné, Briggs, & Wager, 1988; Sugrue, 1994). Motivation and fear of failure influence risk taking and persevering (Legg, 1990).

Intelligence

In the past decade, intelligence has been defined more broadly (Crowl et al., 1997; Kauchak & Eggen, 1998; Kirby & Kuykendall, 1991). Intelligence is

- No longer limited to the idea of a single ability or global capacity to learn, adapt, and think rationally;
- Inclusive in its general and specific abilities to embrace general knowledge, comprehension, thinking, and problem solving;
- Multidimensional in mental processes involving convergent and divergent thinking;

and

- Multilevel, including linguistic-verbal, logical-mathematical, spatial, musical, bodily- kinesthetic, interpersonal, and intrapersonal abilities that influence one's approaches to problem solving and thinking.

Problem Solving

A problem is "a situation in which the individual wants to do something but does not know the course of action needed to get what he or she wants" (Crowl et al., 1997, p. 160). The process of problem solving requires "a series of successive decisions, each of which depends on the outcomes of those that precede it" (p. 189). In a review of research and reports, King, Rohani, and Goodson (1997) have identified 31 problem-solving tasks, from problem finding through evaluation.

Critical Thinking

Some researchers and scholars use the terms "critical thinking" and "higher order thinking" interchangeably, while others define "critical thinking" as a form of higher order thinking. Some use the terms "critical thinking" and "problem solving" interchangeably; yet for others, critical thinking is a form of problem solving. Still others define "critical thinking" as a part of the process of evaluating the evidence collected in problem solving or the results produced by thinking creatively (Crowl et al., 1997; Lewis & Smith, 1993). Critical thinking is a particular domain that has been defined in detail through Gubbins' Matrix of Critical Thinking (cited in Legg, 1990), Facione, P. (n.d.), and the McREL Institute (Marzano, R. J., and others. 1992). Critical thinking also has been described in the following ways:

- Goal-directed, reflective, and reasonable thinking, as in evaluating the evidence for an argument for which all the relevant information may not be available (Cotton, 1997; Crowl et al., 1997; Facione, 1998; Lewis & Smith, 1993; Patrick, 1986)
- An essential component in metacognitive processes (Crowl et al., 1997)
- Analysis, inference, interpretation, explanation, and self-regulation; requires inquisitive, systematic, analytical, judicious, truth-seeking, open-minded, and confident dispositions toward critical-thinking processes (Facione, 1998)
- The disposition to provide evidence or reasoning in support of conclusions, request evidence or reasoning from others, and perceive the total situation and change one's views based on the evidence (Cotton, 1997)

Theories Related to Learning and Higher Order Thinking Skills

No one has yet explained the process of thinking much better than Dewey (1933), who described it as a sequenced chaining of events. According to Dewey, this productive process moves from reflection to inquiry, then to critical thought processes that, in turn, lead to a "conclusion that can be substantiated" (p. 5) by more than personal beliefs and images. Thought can straighten out entanglements, clear obscurities, resolve confusion, unify disparities, answer questions, define problems, solve problems, reach goals, guide inferences, shape predictions, form judgments, support decisions, and end controversies.

According to Dewey, thinking does not occur spontaneously but must be "evoked" by "problems and questions" or by "some perplexity, confusion or doubt." The observations or "data at hand cannot supply the solution; they can only suggest it" (p. 15). Furthermore, it is this "demand for the solution" (p. 14) that steadies and guides the entire process of reflective thinking; the "nature of the problem fixes the end of thought, and the end controls the process of thinking" (p. 15). Dewey's conceptualization parallels current discussion and research about problem solving and metacognitive strategies and the importance of teaching students to think about their own thinking processes (Kauchak & Eggen, 1998). As students become aware of their thinking processes, they realize how their own personal makeup can play a role in how they make their choices and interpret situations (Jacobs, 1994; Tversky & Kahneman cited in Ohio State University, n.d.; Kahneman, Slovic, & Tversky, 1982). Factors such as culture, experience, preferences, desires, interests, and passions can radically alter the decision-making process (Kahneman et al., 1982). Nevertheless, with time and more experience in systematic thinking, individuals and groups can develop the principles to guide decision making so that "a certain manner of interpretation gets weight, authority" as long as "the interpretation settled upon is not controverted by subsequent events" (p. 126).

The following section provides explanations of the work of key learning theorists, practitioners, and researchers in the field of thinking and learning. Researchers and teachers choose from a variety of frameworks for learning, with each framework approaching learning from simpler to more complex stages. However, the frameworks are artificial—they are only meant to be a means of defining the thinking/learning process; they can in no way capture the intricacies of the thinking process. "The boundaries separating the forms of complex thinking are sometimes blurred and somewhat artificial, often reflecting the particular interest of individual investigators" (Crowl et al., 1997, p.170).

Piaget

According to Piaget, the developmental stages are the key to cognitive development. School-age and adolescent children develop operational thinking and the logical and systematic manipulation of symbols. As adolescents move into adulthood, they develop skills such as logical use of symbols related to abstract concepts, scientific reasoning, and hypothesis testing. These skills are the foundation for problem solving, self-reflection, and critical reasoning (Crowl et al., 1997; Miles, 1992). Recent research shows that children perform certain tasks earlier than Piaget claimed, vary in how rapidly they develop cognitively, and seem to be in transition longer than in the cognitive development stages (Crowl et al., 1997). However, research also shows that biological development, together with instructional techniques, affects the rate of movement from one stage of learning to the next.

Bruner

According to Bruner, learning processes involve active inquiry and discovery, inductive reasoning, and intrinsic motivation. Stages of cognitive development are not linear; they may occur simultaneously. Bruner introduced the "spiral curriculum" in which learners return to previously covered topics within the context of new information learned. Both Piaget and Bruner focus on active learning, active inquiry and discovery, inductive reasoning, intrinsic motivation, and linkage of previously learned concepts and information to new learning. Stages include enactive (hands-on participation), iconic (visual representations), and symbolic (symbols, including math and science symbols) (Crowl et al., 1997).

Bloom

In each of Bloom's three taxonomies (cognitive, affective, and psychomotor), lower levels provide a base for higher levels of learning (Bloom, 1956; Kauchak & Eggen, 1998). Comprehension and application form linkages to higher order skills; here, the learner uses meaningful information such as abstractions, formulas, equations, or algorithms in new applications in new situations. Higher order skills include analysis, synthesis, and evaluation and require mastery of previous levels, such as applying routine rules to familiar or novel problems (McDavitt, 1993). Higher order thinking involves breaking down complex material into parts, detecting relationships, combining new and familiar information creatively within limits set by the context, and combining and using all previous levels in evaluating or making judgments. There also appears to be some interaction across taxonomies. For example, the highest level of the psychomotor taxonomy involves the use of our body's psychomotor, affective, and cognitive skills to express feelings or ideas as in the planning and execution of a dance performance or song designed to convey a particular message.

Gagné

According to Gagné, intellectual skills begin with establishing a hierarchy according to skill complexity. Within this structure, discriminations are prerequisites for concrete and defined concepts, simple rules, complex higher order rules, and then problem solving.

Cognitive strategies may be simple or complex (Gagné, 1985; Briggs & Wager, 1981; Gagné, Briggs, & Wager, 1988). Attitudes and motor skills, related varieties of learning, may involve lower as well as higher order thinking—spanning from a simple application of a tool to a complex systems analysis and evaluation. Bloom (1956) and Gagné and Briggs (1974) allow for greater possibilities of teaching complex skills to younger learners and the possibility that learners can be "young" at any age, starting at lower levels and connecting to higher levels of thinking. This variation for learning capabilities does not fit as well in Piaget's and Bruner's frameworks.

Marzano

To Marzano, the dimensions of thinking (Table 1) feed into dimensions of learning, both of which build upon contributions from other scholars and researchers (Marzano et al., 1988). For example, Gagné refers to the generalizations that describe relationships between or among concepts as "rules" (Gagné, 1974; Gagné, Briggs, & Wager, 1988), while Marzano calls them "principles" (Marzano et al., 1988, p. 37). The book Dimensions of Thinking has been designed as a practical handbook with definitions, examples, and classroom applications.

Idity of measures of higher order thinking skills is more difficult than assessing those of lower order thinking skills. It is necessary to verify that higher order processes were used in arriving at correct answers. For example, some items (especially multiple-choice) must be answered through the use of higher order thinking by students who have not previously encountered the problems presented. Other students can arrive at correct answers to the same items by calling on prior knowledge. In addition to those related to the influence of prior