Appendix

Appendix

Appendix A

Frameworks for Describing Thinking

Teaching Higher-Order Thinking

Thinking beyond the level of knowledge acquisition is considered complex thinking. Complex thinking requires effort and produces outcomes that may differ from one person to another. The outcomes are not predictable because the process of higher-order thinking is not mechanical. Central to higher-order thinking is the ability to work through new challenges with understanding and empathy and rise to meet those challenges. Current research on higher-order thinking points to a clear conclusion. Instruction that builds on and encourages the use of higher-order thinking skills yields greater levels of student learning. Gains on learning and intelligence measures have been tied to instruction that use a variety of specific techniques (Cotton, 1991), including:

- CREATIVE AND CRITICAL THINKING SKILLS, such as decision making, problem solving, fluency, observation, exploration, classification, and generating hypotheses

- METACOGNITION, including awareness, self-monitoring, and self-regulating

To learn more about teaching thinking, explore the Teaching Thinking section of the Intel® Education *Designing Effective Projects* Web site at:
http://educate.intel.com/en/ProjectDesign/ThinkingSkills/TeachingThinking/

Many frameworks have been developed by educational thinkers to help educators and researchers identify and categorize thinking skills. As you read through the following frameworks, consider which ways of looking at thinking best suit your teaching style and subject area.

Bloom's Taxonomy of Educational Objectives (Traditional)

In 1956, Benjamin Bloom wrote *Taxonomy of Educational Objectives: Cognitive Domain*, and his six-level description of thinking has been widely adapted and used in countless contexts ever since. His list of cognitive processes is organized from the simplest, the recall of knowledge, to the most complex, making judgments about the value and worth of ideas.

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Skill	Definition	Key Words
Knowledge	Recall information	Identify, describe, name, label, recognize, reproduce, follow
Comprehension	Understand meaning, paraphrase concepts	Summarize, convert, defend, paraphrase, interpret, give examples
Application	Use information or concepts in new situations	Build, make, construct, model, predict, prepare
Analysis	Break information or concepts into parts to understand it more fully	Compare/contrast, break down, distinguish, select, separate
Synthesis	Put ideas together to form something new	Categorize, generalize, reconstruct
Evaluation	Make value judgments	Appraise, critique, judge, justify, argue, support

Revised Bloom's Taxonomy

In 1999, Dr. Lorin Anderson, a former student of Bloom's, and his colleagues published an updated version of Bloom's Taxonomy that takes into account a broader range of factors that impact teaching and learning. This revised taxonomy attempts to correct some of the shortcomings found in the original taxonomy. Unlike the 1956 version, the revised taxonomy differentiates between *knowing what* (the content of thinking) and *knowing how* (the procedures used in solving problems).

Cognitive Processes Dimensions

Remembering—Produce the right information from memory Recognizing, recalling
Understanding—Make meaning from educational materials or experiences Interpreting, exemplifying, classifying, summarizing, inferring, comparing, explaining
Applying—Use a procedure Executing, implementing
Analyzing—Break down a concept into its parts and describe how the parts relate to the whole Differentiating, organizing, attributing
Evaluating—Make judgments based on criteria and standards Checking, critiquing
Creating—Put pieces together to form something new or recognize components of a new structure Generating, planning, producing

(continued)

The Knowledge Dimension

Factual Knowledge—Basic information Terminology, specific details and elements
Conceptual Knowledge—Relationships among pieces of a larger structure that make them function together Classifications and categories; principles and generalizations; theories, models, and structures
Procedural Knowledge—How to do something Subject-specific skills, algorithms, techniques, and methods; criteria for determining when to use appropriate procedures
Metacognitive Knowledge—Understand of thinking in general and your thinking in particular Strategies, cognitive task requirements, self-knowledge

For more information about the traditional and revised Bloom's frameworks for describing thinking, visit the following Web site:

http://educate.intel.com/en/ProjectDesign/ThinkingSkills/ThinkingFrameworks/Bloom_Taxonomy.htm

Marzano's New Taxonomy

Robert Marzano, a respected educational researcher, has proposed what he calls *A New Taxonomy of Educational Objectives* (2000). Marzano developed his new taxonomy to respond to the shortcomings of the widely used Bloom's Taxonomy and the current environment of standards-based instruction. Marzano's model of thinking skills incorporates a wide range of factors that affect how students think and provides a strong research-based theory to help teachers improve students' thinking.

The Three Systems and Knowledge

Self-System		
Beliefs about the Importance of Knowledge	Beliefs about Efficacy	Emotions Associated with Knowledge

Metacognitive System			
Specifying Learning Goals	Monitoring the Execution of Knowledge	Monitoring Clarity	Monitoring Accuracy

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Cognitive System			
Knowledge Retrieval	**Comprehension**	**Analysis**	**Knowledge Utilization**
Recall Execution	Synthesis Representation	Matching Classifying Error Analysis Generalizing Specifying	Decision Making Problem Solving Experimental Inquiry Investigation

Knowledge Domain		
Information	Mental Procedures	Physical Procedures

For further information about Marzano's Taxonomy, visit the following Web site: **http://educate.intel.com/en/ProjectDesign/ThinkingSkills/ThinkingFrameworks/Marzano_New_Taxonomy.htm**

Related Frameworks

While the taxonomies of Bloom and Marzano continue to be the most well-known ways of describing levels of thinking, other educators have also contributed significant ideas to this important field.

Paulo Freire and Critical Literacy

The educational approaches of Brazilian educator Paulo Freire have had a significant impact around the world, but particularly in Latin America. Freire's framework, which is based on his experience teaching literacy to poor adults in South America, focuses on the role of education in empowering people to transform their lives.

Freire's work critiques what he calls the "banking" theory of education. From this perspective, teachers hold all the important knowledge. They "deposit" the knowledge into the minds of their students, and students "patiently receive, memorize, and repeat" what they have learned (Freire, 1993, p. 43). Freire proposes that individuals learn in the context of the world they live in, with real-life problems and situations.

Freire's model of education emphasizes higher-order thinking, but the kind of thinking he promotes is situated in a revolutionary context. He maintains that all aspects of a person's life, reading and writing as well as everyday tasks, take place in a political and social arena. Learning to read the "world" as well as the "word" helps people understand how they have been oppressed and empowers them to become liberated. This process from oppression to liberation is called praxis, "the action and reflection of men and women upon their world in order to transform it" (Freire, 1993, p. 51).

Freire's approach to education is often called *critical literacy*. This approach is similar to what other thinkers in this area would call *critical thinking*, but critical literacy incorporates a decidedly political perspective. Critical thinking, in the traditional sense, asks thinkers to examine their own biases and assumptions, so they can ask questions of texts and ideas, in order to discover the truth. In contrast, critical literacy assumes that language is always used for a political purpose. When people are critically literate, they go beyond recognizing the flaws in their own thinking to identifying how language preserves oppressive power structures.

For further information about Freire and his educational theories, visit the following Web sites:

Paulo Freire: Chapter 2 of *The Pedagogy of the Oppressed*
www.webster.edu/~corbetre/philosophy/education/freire/freire-2.html
The second chapter of Freire's landmark book on pedagogy and critical literacy

Paulo Freire
www.ibe.unesco.org/publications/thinkers.htm (PDF, 16 pages, English, French, Spanish)
A biography of Freire and his theories published by UNESCO (United Nations Educational, Scientific, and Cultural Organization)

Howard Gardner and Multiple Intelligences

Throughout the last decade, a growing number of educators have adopted Howard Gardner's theory of multiple intelligences. Logical/mathematical and linguistic intelligences—the two ways of thinking most valued in schools—are only two of eight intelligences described by Gardner. According to Gardner's biological and cultural research, the other six intelligences are spatial, musical, bodily/kinesthetic, interpersonal, intrapersonal, and naturalist.

Logical-Mathematical	Ability to detect patterns, reason deductively, and think logically. This intelligence is most often associated with scientific and mathematical thinking.
Linguistic	Mastery of language. This intelligence includes the ability to effectively manipulate language to express oneself rhetorically or poetically. It also allows one to use language as a means to remember information.
Spatial	Ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains.
Musical	Capability to recognize and compose musical pitches, tones, and rhythms.

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Bodily-Kinesthetic	Ability to use one's mental capacities to coordinate one's own bodily movements. This intelligence challenges the popular belief that mental and physical activity are unrelated (ERIC, 1996, p. 2).
Interpersonal	Core capacity to notice distinctions among others; in particular contrasts in their moods, temperaments, motivations, and intentions (Gardner, 1993, p. 42).
Intrapersonal	Access to one's own feeling life, one's range of emotions, the capacity to effect discriminations among emotions and eventually to label them and to draw on them as a means of understanding and guiding one's own behavior (Gardner, 1993, p. 44).
Naturalist	Expertise in the recognition and classification of plants and animals. The same skills of observing, collecting, and categorizing might also be applied in the "human" environment (Campbell, 2003, p. 84).

Costa and Kallick and 16 Habits of Mind

Art Costa and Bena Kallick identified the 16 Habits of Mind used by effective thinkers when confronted with a challenging problem. Art Costa says a habit of mind "is knowing how to behave when you don't know the answer" (Costa & Kallick, 2000–2001). Employing a habit of mind requires many skills, attitudes, and learned behaviors. These behaviors are not performed in isolation but in clusters. The 16 Habits of Mind (shown in the following table) is not a complete list, but it's a beginning point for discussion on how people display their intelligence.

16 Habits of Mind	Description
Persisting	Ability to sustain a problem solving process over time.
Managing Impulsivity	Ability to think before acting, intentionally forming a plan before beginning a task.
Listening to Others with Understanding and Empathy	Ability to listen to other people, to empathize with and to understand their points of view.
Thinking Flexibly	Capacity to change one's mind as additional data is received. Ability to approach a problem from a new angle using a novel approach.

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16 Habits of Mind	Description
Thinking about Thinking (Metacognition)	Ability to develop a plan of action, maintain that plan in mind over a period of time, and then reflect on and evaluate the plan after its completion. Aware of one's actions and the effect of those actions on others and on the environment. Ability to explain one's strategies of decision making.
Striving for Accuracy and Precision	Valuing of accuracy, precision, and craftsmanship.
Questioning and Posing Problems	Knowing how to ask questions to fill in the gaps between what is known and unknown. Ability to recognize discrepancies and phenomena in one's environment and probe into their causes.
Applying Past Knowledge to New Situations	Ability to abstract meaning from one experience, carry it forth, and apply it in a new and novel situation.
Thinking and Communicating with Clarity and Precision	Striving to communicate accurately in both written and oral form, taking care to use precise language, define terms, and use correct names, universal labels, and analogies.
Gathering Data through All Senses	Deriving information from the environment by observing or taking it in through the senses.
Creating, Imagining, and Innovating	Trying to conceive problem solutions differently, examining alternative possibilities from many angles, using analogies, starting with a vision and working backward, taking risks, and pushing the boundaries of one's perceived limits.
Responding with Wonderment and Awe	Maintaining curiosity, enthusiasm, and passion about learning, inquiring, and mastering.
Taking Responsible Risks	Accepting confusion, uncertainty, and the higher risks of failure as part of the normal process. Learning to view set-backs as interesting, challenging, and growth producing.
Finding Humor	Using humor and laughter to liberate creativity and provoke such higher-level thinking skills as anticipation, finding novel relationships, visual imagery, and making analogies. Having a whimsical frame of mind, finding incongruity, and perceiving absurdities, ironies, and satire.
Thinking Interdependently	Heightened ability to think in concert with others. Ability to justify ideas and to test the feasibility of solution strategies on others. Willingness and openness to accept the feedback from a critical friend.
Learning Continuously	Constantly searching for new, better ways and always striving for improvement, growth, knowledge, self-modification, and self-improvement.

Summarized from: Costa & Kallick's "Describing 16 Habits of Mind".

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Learn more about the 16 Habits of Mind by visiting the following Web site:
http://educate.intel.com/en/ProjectDesign/ThinkingSkills/BeliefsAndAttitudes/ Habits_of_Mind.htm

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Bloom, B. S. (Ed.). 1956. *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York: Longman.

Costa, A. L. & Kallick, B. (2000). *Describing 16 Habits of Mind. (Adapted from Habits of mind: A developmental series*. Alexandria, VA: Association for Supervision and Curriculum Development). Retrieved from: www.habits-of-mind.net/pdf/16HOM2.pdf

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Freire, P. (1972). *Pedagogy of the oppressed*. London: Herder and Herder.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Harper Collins.

Marzano, R. J. (2000). *Designing a new taxonomy of educational objectives.* Thousand Oaks, CA: Corwin Press.

Appendix B

Resources

You might consider reading the resources in this section to learn more about the featured educational theories and methods. **[NOTE: The localization team needs to insert the names of print and Internet resources available in the local language.]**

Books

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: ASCD. ISBN: 0-87120-358-8.

Campbell, L., Campbell, B., & Dickinson, D. (2004). *Teaching and learning through multiple intelligences, 3rd edition*. Boston, MA: Allyn & Bacon. ISBN: 0-2-5-36390-3.

Johnson, D. W., Johnson, R. T., & Johnson Holubec, E. (1998). *Cooperation in the classroom, 7th edition*. Edina, MN: Interaction Book Company. ISBN: 0-939603-04-7.

Kagan, S. (1994). *Cooperative learning*. San Clemente, CA: Kagan Cooperative Learning. ISBN: 1-879097-10-9.

Katz, L. G., & Chard, S. C. (2000). *Engaging children's minds: The project approach, 2nd edition*. Stamford, CT: Ablex Publishing Corporation. ISBN: 1-56750-500-7.

Moursund, D. (2003). *Project-based learning using information technology, 2nd edition*. Eugene, OR: ISTE. ISBN: 1-56484-196-0.

National Research Council. (2000). *How people learn: Brain, mind, experience, and school, expanded edition*. Washington, DC: National Academy Press. ISBN: 0309070368.

Torp, L., & Sage, S. (2002). *Problems as possibilities: Problem-based learning for K–16 education*. Alexandria, VA: ASCD. ISBN: 0-87120-574-2.

21st Century Skills Internet Resources

Digital Transformation: A Framework for ICT Literacy (2002)
www.ets.org (Research Monographs, 52 pages)

EnGauge 21st Century Skills (2003)
www.ncrel.org/engauge/skills/engauge21st.pdf (PDF, 88 pages)

Learning for the 21st Century (2004)
www.21stcenturyskills.org/index.php?option=com_content&task=view&id=29 &Itemid=42

Bloom's Taxonomy of Thinking Skills Internet Resources

Bloom's Revised Taxonomy
http://coe.sdsu.edu/eet/articles/bloomrev/index.htm

Task Oriented Question Construction Wheel Based on Bloom's Taxonomy
www.stedwards.edu/cte/resources/bwheel.htm

Learning Domains or Bloom's Taxonomy
www.nwlink.com/~donclark/hrd/bloom.html

Applying Bloom's Taxonomy
www.teachers.ash.org.au/researchskills/dalton.htm

Facilitation Skills Internet Resources

Coaching to Improve Classroom Literacy Instruction
http://cri.cps.k12.il.us/workshop_materials/classroom_observations.ppt

Facilitation: A Different Pedagogy?
By Ms Shu Moo Yoong
www.cdtl.nus.edu.sg/link/mar2002/tm4.htm

Graduating from Teacher to Facilitator in the Technology-Rich Classroom
www.4teachers.org/testimony/webb/index.shtml

Introduction to Teaching: Facilitation Skills
http://discovery.rp.edu.sg/home/CED/facilitators/skills.htm

On Giving Good Directions
www.youthlearn.org/learning/teaching/directions.asp

Starter Activities: Belief Circles—Suggested Statements
www.sda-uk.org/statements.html

The Teacher as Facilitator by Vito Perrone
www.learningpod.com/article/0,1120,5-2166,00.html

Other Internet Resources

A Lexicon of Learning: What Educators Mean When They Say…
www.ascd.org/cms/index.cfm?TheViewID=1112

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