Designing Effective Projects: Thinking Skills Frameworks
Bloom's Taxonomy: A New Look at an Old Standby

Traditional Hierarchy of Thinking Processes

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 most simple, the recall of knowledge, to the most complex, making judgments about the value and worth of an idea.

Bloom's Taxonomy of Educational Objectives (Traditional)

Skill	Definition	Key Words
Knowledge	Recall information	Identify, describe, name, label, recognize, reproduce, follow
Comprehension	Understand the meaning, paraphrase a concept	Summarize, convert, defend, paraphrase, interpret, give examples
Application	Use the information or concept in a new situation	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 judgments about value	Appraise, critique, judge, justify, argue, support

Today's world is a different place, however, than the one Bloom's Taxonomy reflected in 1956. Educators have learned a great deal more about how students learn and teachers teach and now recognize that teaching and learning encompasses more than just thinking. It also involves the feelings and beliefs of students and teachers as well as the social and cultural environment of the classroom.

Several cognitive psychologists have worked to make the basic concept of a taxonomy of thinking skills more relevant and accurate. In developing his own taxonomy of educational objectives, Marzano (2000) points out one criticism of Bloom's Taxonomy. The very structure of the Taxonomy, moving from the simplest level of knowledge to the most difficult level of evaluation, is not supported by research. A hierarchical taxonomy implies that each higher skill is composed of the skills beneath it; comprehension requires knowledge; application requires comprehension and knowledge, and so on. This, according to Marzano, is simply not true of the cognitive processes in Bloom's Taxonomy.

The originators of the original six thinking processes assumed that complex projects could be labeled as requiring one of the processes more than the others. A task was primarily an "analysis" or an "evaluation" task. This has been proven not to be true which may account for the difficulty that educators have classifying challenging learning activities using the Taxonomy. Anderson (2000) argues that nearly all complex learning activities require the use of several different cognitive skills.

Like any theoretical model, Bloom's Taxonomy has its strengths and weaknesses. Its greatest strength is that it has taken the very important topic of thinking and placed a structure around it that is usable by practitioners. Those teachers who keep a list of question prompts relating to the various levels of Bloom's Taxonomy undoubtedly do a better job of encouraging higher-order thinking in their students than those who have no such tool. On the other hand, as anyone who has worked with a group of educators to classify a group of questions and learning activities according to the Taxonomy can attest, there is little consensus about what seemingly self-evident

terms like “analysis,” or “evaluation” mean. In addition, so many worthwhile activities, such as authentic problems and projects, cannot be mapped to the Taxonomy, and trying to do that would diminish their potential as learning opportunities.

Revised Bloom’s Taxonomy
In 1999, Dr. Lorin Anderson, a fromer 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 have an impact on teaching and learning. This revised taxonomy attempts to correct some of the problems with 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.

The Knowledge Dimension is the “knowing what.” It has four categories: *factual, conceptual, procedural,* and *metacognitive*. Factual knowledge includes isolated bits of information, such as vocabulary definitions and knowledge about specific details. Conceptual knowledge consists of systems of information, such as classifications and categories.

Procedural knowledge includes algorithms, heuristics or rules of thumb, techniques, and methods as well as knowledge about when to use these procedures. Metacognitive knowledge refers to knowledge of thinking processes and information about how to manipulate these processes effectively.

The Cognitive Process Dimension of the revised Bloom’s Taxonomy like the original version has six skills. They are, from simplest to most complex: remember, understand, apply, analyze, evaluate, and create.

Remembering
Remembering consists of recognizing and recalling relevant information from long-term memory.

Understanding
Understanding is the ability to make your own meaning from educational material such as reading and teacher explanations. The subskills for this process include interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

Applying
The third process, *applying*, refers to using a learned procedure either in a familiar or new situation.

Analysis
The next process is *analysis*, which consists of breaking knowledge down into its parts and thinking about how the parts relate to its overall structure. Students analyze by differentiating, organizing, and attributing.

Evaluation
Evaluation, which is at the top of the original taxonomy, is the fifth of the six processes in the revised version. It includes checking and critiquing.

Creating
Creating, a process not included in the earlier taxonomy, is the highest component of the new version. This skill involves putting things together to make something new. To accomplish creating tasks, learners generate, plan, and produce.

According to this taxonomy, each level of knowledge can correspond to each level of cognitive process, so a student can remember factual or procedural knowledge, understand conceptual or metacognitive knowledge, or analyze metacognitive or factual knowledge. According to Anderson and his colleagues, “Meaningful learning provides students with the knowledge and cognitive

processes they need for successful problem solving". The following charts list examples of each skill of the Cognitive and Knowledge Dimensions.

Cognitive Processes Dimensions

Cognitive Processes	Examples
Remembering—Produce the right information from memory	
Recognizing	• Identify frogs in a diagram of different kinds of amphibians. • Find an isosceles triangle in your neighborhood. • Answer any true-false or multiple-choice questions.
Recalling	• Name three 19th-century women English authors. • Write the multiplication facts. • Reproduce the chemical formula for carbon tetrachloride.
Understanding—Make meaning from educational materials or experiences	
Interpreting	• Translate a story problem into an algebraic equation. • Draw a diagram of the digestive system. • Paraphrase Lincoln's Second Inaugural Address.
Exemplifying	• Draw a parallelogram. • Find an example of stream-of-consciousness style of writing. • Name a mammal that lives in our area.
Classifying	• Label numbers odd or even. • List the kinds of governments found in modern African nations. • Group native animals into their proper species.
Summarizing	• Make up a title for a short passage. • List the key points related to capital punishment that the Web site promotes.
Inferring	• Read a passage of dialogue between two characters and make conclusions about their past relationship. • Figure out the meaning of an unfamiliar term from the context. • Look at a series of numbers and predict what the next number will be.
Comparing	• Explain how the heart is like a pump. • Write about an experience you have had that was like the pioneers moving west. • Use a Venn diagram to demonstrate how two books by Charles Dickens are similar and different.
Explaining	• Draw a diagram explaining how air pressure affects the weather. • Provide details that justify why the French Revolution happened when and how it did. • Describe how interest rates affect the economy.
Applying—Use a procedure	
Executing	• Add a column of two-digit numbers. • Orally read a passage in a foreign language. • Pitch a baseball.
Implementing	• Design an experiment to see how plants grow in different kinds of soil. • Proofread a piece of writing. • Create a budget.
Analyzing—Break a concept down into its parts and describe how the parts relate to the whole	
Differentiating	• List the important information in a mathematical word problem

	and cross out the unimportant information. • Draw a diagram showing the major and minor characters in a novel.
Organizing	• Place the books in the classroom library into categories. • Make a chart of often-used figurative devices and explain their effect. • Make a diagram showing the ways plants and animals in your neighborhood interact with each other.
Attributing	• Read letters to the editor to determine the authors' points of view about a local issue. • Determine a character's motivation in a novel or short story. • Look at brochures of political candidates and hypothesize about their perspectives on issues.
Evaluating—Make judgments based on criteria and standards	
Checking	• Participate in a writing group, giving peers feedback on organization and logic of arguments. • Listen to a political speech and make a list of any contradictions within the speech. • Review a project plan to see if all the necessary steps are included.
Critiquing	• Judge how well a project meets the criteria of a rubric. • Choose the best method for solving a complex mathematical problem. • Judge the validity of arguments for and against astrology.
Creating—Put pieces together to form something new or recognize components of a new structure.	
Generating	• Given a list of criteria, list some options for improving race relations in the school. • Generate several scientific hypotheses to explain why plants need sunshine. • Propose a set of alternatives for reducing dependence on fossil fuels that address both economic and environmental concerns. • Come up with alternative hypotheses based on criteria.
Planning	• Make a storyboard for a multimedia presentation on insects. • Outline a research paper on Mark Twain's views on religion. • Design a scientific study to test the effect of different kinds of music on hens' egg production.
Producing	• Write a journal from the point of view of a confederate or union soldier. • Build a habitat for local water fowl. • Put on a play based on a chapter from a novel you're reading.

The Knowledge Dimension

Factual Knowledge—Basic information	
Knowledge of terminology	Vocabulary terms, mathematical symbols, musical notation, alphabet
Knowledge of specific details and elements	Components of the Food Pyramid, names of congressional representatives, major battles of WWII
Conceptual Knowledge—The relationships among pieces of a larger structure that make them function together	

Knowledge of classifications and categories	Species of animals, different kinds of arguments, geological eras
Knowledge of principles and generalizations	Types of conflict in literature, Newton's Laws of Motion, principles of democracy
Knowledge of theories, models, and structures	Theory of evolution, economic theories, DNA models
Procedural Knowledge—How to do something	
Knowledge of subject-specific skills and algorithms	Procedure for solving quadratic equations, mixing colors for oil painting, serving a volleyball
Knowledge of subject-specific techniques and methods	Literary criticism, analysis of historical documents, mathematical problem-solving methods
Knowledge of criteria for determining when to use appropriate procedures	Methods appropriate for different kinds of experiments, statistical analysis procedures used for different situations, standards for different genres of writing
Metacognitive Knowledge—Knowledge of thinking in general and your thinking in particular	
Strategic knowledge	Ways of memorizing facts, reading comprehension strategies, methods of planning a Web site
Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge	Different reading demands of textbooks and novels; thinking ahead when using an electronic database; differences between writing emails and writing business letters
Self-knowledge	Need for a diagram or chart to understand complex processes, better comprehension in quiet environments, need to discuss ideas with someone before writing an essay

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