Cognitivist Theories II: Taxonomies of Learning (A Hitchhiker's Guide to Learning Theory)

Patrick Parrish, WMO

Learning Domains

Because cognitive theories of learning are concerned with HOW people think and learn, it follows that they would define different kinds of cognitive processes.

Some types of thinking are more complex, and require more effort and more study than others. Learning can be shallow—if we want people just to memorize something. Or it can be deep—if we want people to become expert weather forecasters, or creative instructional designers, for example. If we want people to learn deeply, it may be helpful to decide what our learning outcomes entail and design learning activities that are appropriate for them. One of the major contributions of cognitive theories is the development of taxonomies of learning intended to help educators and trainers do just this.

Most broadly, learning has been divided into three domains:

- Cognitive (all types of thinking and deliberation)
- Affective (attitudes and values)
- Motor skills (physical tasks requiring dexterity and hand/eye coordination)

These distinctions help us realize that there is a wide variety in learning, and that the domains of learning call for different kinds of learning approaches. Some theorists have worked to define how affective and motor skills learning should occur, but most of the emphasis in learning theories relates to the cognitive domain, because this domain is more highly valued in our information age. But all of us also need to learn affective skills as well, like what it means to act professionally and work in groups. And all of us also need to learn physical tasks, of course, like skiing or driving a car, for example. But most professions these days are based on the particular cognitive skills they require.

Declarative and Procedural Knowledge

The cognitive domain has been subdivided in a variety of ways. The most simple and probably most influential is the division between *declarative knowledge* and *procedural knowledge*, which was proposed by John Anderson in the 1980's.

Declarative knowledge is "knowing that," such as knowing that something is defined a certain way, that it has certain qualities, or that it occurs under certain conditions. Knowledge of the "knowing that" category can be expressed in words or diagrams since it is the knowledge of semantic relationships. Facts, concepts, and principles are declarative knowledge because we can adequately explain them either verbally or visually. This doesn't mean declarative knowledge is trivial. It can be extremely hard to learn, and can require significant effort to understand. Being able to explain the Theory of Special Relativity is declarative knowledge for example, and the ability to classify cloud types would typically be called declarative knowledge.

Procedural knowledge is "knowing how." It is knowledge about how to accomplish tasks—what steps to take, what decisions to make, how to know when we have a good solution. It relies on declarative knowledge, but it includes application in ways that declarative knowledge doesn't suggest on its own. Procedural knowledge is hard to convey in words alone. For true understanding, it requires demonstration, and for learning, it requires practice performing the procedures. Problem solving, decision making, and analyzing data are all based on procedural knowledge.

Information, Skills, and Strategies

Also in the 1980's, which was the heyday of cognitive learning theories, Robert Gagne proposed a division of the cognitive domain with one additional category. By the way, Gagne is famous for writing the first textbook on instructional design. In his scheme, knowledge can be classified as either verbal information, intellectual skills, or cognitive strategies. Verbal information is similar to declarative knowledge, it describes information that someone can state or tell about, or depict visually. Again, this doesn't mean simple memory of facts, it can include quite complex concepts and principles. Intellectual skills, on the other hand, are demonstrated when someone interacts with and applies verbal information to complete a task. Making a weather forecast is a very complex intellectual skill.

Cognitive strategies are also a critical kind of knowledge, because they are what allow us to be conscious of and manage our learning, remembering, and thinking. Cognitive strategies are often referred to as "metacognition", or the ability to reflect about our own thinking. Without metacognition, we would not be able to carry out complex cognitive tasks with skill or good judgment. Professionals need to learn metacognition as much as intellectual skills and verbal information. Too often, instruction stops with verbal information, but learning activities like simulations that require reflection call for all three kinds of learning.

Bloom's Taxonomy

The most famous taxonomy of learning is Bloom's Taxonomy, which has been used for nearly 50 years to help classify learning objectives. It goes into a bit more detail, and helps to distinguish learning based on its level of complexity. The taxonomy has evolved over the years, and there are many variations, but all are similar in their fundamental distinctions. Starting at the lower levels, then progressing in to the murkier higher levels:

- Knowledge: Describes information that the learner has to remember or recall. This can be concrete facts, or abstract concepts. It is suspiciously similar to declarative knowledge. (Knowledge is a particularly bad choice of terms, since the word "knowledge" usually describes many types of intellectual abilities, beyond just recalling. But in this scheme, this is what you get. I suspect it should have been labeled, Recall, which it is in other schemes.)
- Comprehension, or Understanding: This is a level in which learners are able not just to recall, but also use information to extrapolate meanings, to discuss it, and to explain it in their own words. Explaining something is more complex than simply recalling how it's defined.
- Application: This level is when a person can use what they've learned to make decisions or follow procedures. It's very similar to procedural knowledge. I find this a quite ambiguous level,

because it is hard to describe learning that isn't somehow following a procedure. Even the ability to develop a valid theory requires an application level of learning.

- Analysis: When we analysyze, we are able to look at information and determine what is most important, how it is organized, what it has in common with other information, and how it can be classified. This is sometimes called critical thinking.
- Synthesis, or Creating: This is more frequently now placed at the highest level, but originally Bloom put it at the second highest level. Synthesis is using information in creative ways, generating, planning, or producing something new. Making a weather forecast might at times be considered synthesis, but often it is simply an analysis process, depending on the challenge presented, and on how unusual or extreme the situation.
- Evaluation: Whether this is the highest or second highest level, skilled evaluation requires sufficiently deep intellectual skills to determine the value of ideas, products, or solutions. Whether evaluating or creating is more complex isn't really worth debating.

Limitations

Taxonomies are useful to help describe the relative complexity of types of learning, and to remind us that there is more than one kind of learning, but they need to be used with flexibility. It is hard to say whether any single cognitive action fits only one classification. Even for something as seemingly clear as identifying an instance of a concept, like a meteorological observer recognizing a severe convective storm, is this an example of using declarative knowledge? Or is the use of a concept a process, comparing the visible cloud against a set of criteria until you determine if it is severe or not? Or is it a process of evaluating the situational qualities that suggest that the cloud is likely to be a severe convective storm? And can someone perform such an observation without checking his thought processes through metacognition to see if the judgment is reasonable and all things have been considered? The process requires all sorts of knowledge, and all sorts of learning. What we call it is less important than recognizing that it is a complex cognitive act, and that learning verbal information is not enough to be able to do it. It takes experience.