Aviation Instructor's Handbook (FAA-H-8083-9)

Chapter 3: The Learning Process

Introduction

The First Flight

When Beverly (learner) enthusiastically presents herself for her first day of flight instruction, Bill, her flight instructor, decides to spend some time in the classroom. Beverly knows a lot of facts about flying and shares her knowledge with Bill, but when he asks questions to test her understanding of the facts, she cannot answer them. During their first flight, Bill discovers Beverly has mastered a few basic skills but her performance is awkward, as if she were working from a list of memorized steps.

In the early stages of flight training, Beverly focuses all her attention on performing each skill. If Bill asks her a question or to perform two tasks at once, she loses her place and needs to restart. As she flies, she makes errors. When she catches herself making an error she becomes visibly frustrated. Then sometimes she does not notice an error and keeps moving ahead as if nothing were amiss. Since she is a beginner, Bill is patient.

The Check Ride

Months later, Bill is helping Beverly prepare for her practical test. Remembering her first days of instruction, Bill feels as if he were working with a different person. The breadth and depth of her classroom knowledge has grown. Beverly does not simply reiterate facts—she applies her knowledge to solve the problems Bill gives her. In addition to meeting all the elements listed in the Airmen Certification Standards (ACS), she also knows about her local environment, such as the nuances of local weather patterns.

In the aircraft, once awkward and tentative actions are now performed with a steady hand and confidence. Skills she struggled to learn in the past have become second nature. When asked to do several things simultaneously, she performs well. When Bill interrupts her, she mentally bookmarks where she is, contends with the interruption and then returns to the task at hand. She still makes errors, but they are small ones that she notices and corrects right away. She still gets frustrated when she makes an error, but she takes a deep breath, and continues on her way. She makes flying look easy and Bill is confident that tomorrow's meeting with the evaluator will go well.

Analysis of the First Flight and Check Ride

Between Beverly's first day of training and the day before her practical test, she has undergone some remarkable changes:

1. She has developed a collection of memorized facts into an in-depth understanding of how to fly and learned to apply this knowledge to problem-solving and decision-making.

2. Skills once performed awkwardly and deliberately are now performed smoothly and efficiently.

3. She comfortably performs several tasks at once, deals with distractions and interruptions, and maintains her focus in demanding situations. Knowledge and skills are now orchestrated.

4. She still makes errors, but they are less frequent, smaller in magnitude, and she quickly identifies and corrects them.

5. Her motivation and enthusiasm remain as high as they were on the first day of training.

6. She displays proficiency in all areas now: those at which she naturally excels as well as those she struggled to master in the past.

7. She deals with psychological obstacles, such as frustration, that initially got in the way of her learning.

8. She recognizes the importance of regular study and practice.

This scenario illustrates the goal of an aviation instructor: to teach each learner in such a way that he or she will become a competent pilot or aviation maintenance technician (AMT). In order to take a pilot or AMT from memorized facts to higher levels of knowledge and skill that include the ability to exercise judgment and solve problems, an instructor needs to know how people learn. Designed as a basic guide in applied educational psychology, this chapter addresses how people learn.

What is Learning?

Learning can be defined in many ways:

- A change in the behavior of the learner as a result of experience. The behavior can be physical and overt, or it can be intellectual or attitudinal.
- The process by which experience brings about a relatively permanent change in behavior.
- The change in behavior that results from experience and practice.
- Gaining knowledge or skills, or developing a behavior, through study, instruction, or experience.
- The process of acquiring knowledge or skill through study, experience, or teaching. It depends on experience and leads to long-term changes in behavior potential. Behavior potential describes the possible behavior of an individual (not actual behavior) in a given situation in order to achieve a goal.
- A relatively permanent change in cognition, resulting from experience and directly influencing behavior.

The effective instructor understands the subject being taught, the learner, the learning process, and the interrelationships that exist. An effective instructor also realizes learning is a complex procedure and assists each learner in reaching the desired outcomes while helping build self-esteem and confidence. *[Figure 3-1]*

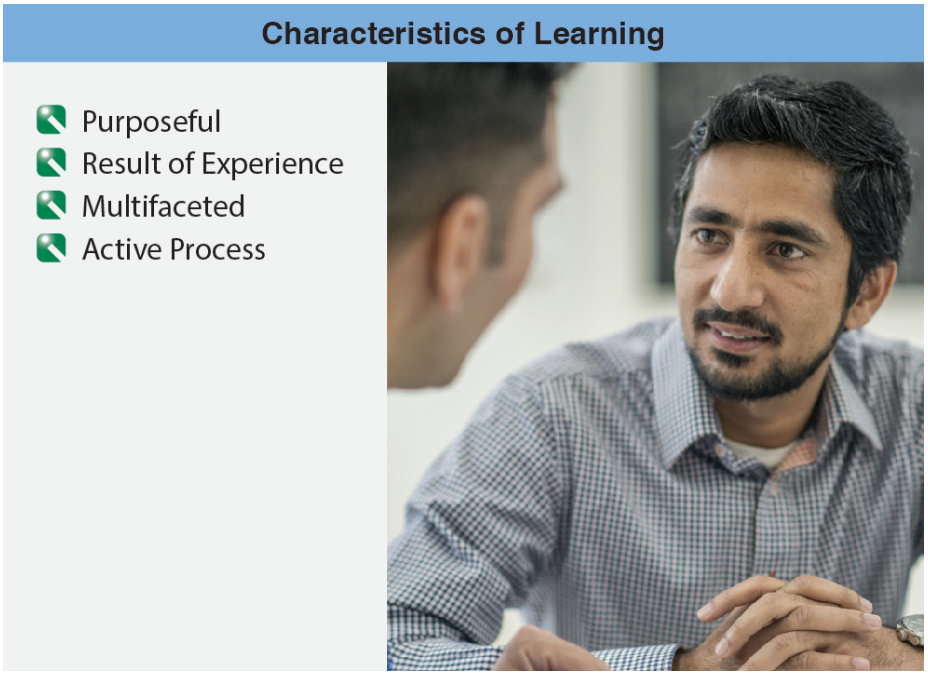

Figure 3-1. *An effective instructor understands the characteristics of learning and assists accordingly.*

The Framework for Learning

Research into how people learn gained momentum with the Swiss scientist and psychologist Jean Piaget, who studied the intellectual development of children in the early twentieth century. His studies influenced others to research not only how people learn, but also the best ways to teach them, leading eventually to the establishment of the field of educational psychology.

Learning Theory

Learning theory is a body of principles advocated by psychologists and educators to explain how people acquire skills, knowledge, and attitudes. Primary learning theories include classical and operant conditioning and social learning. *[Figure 3-2]*

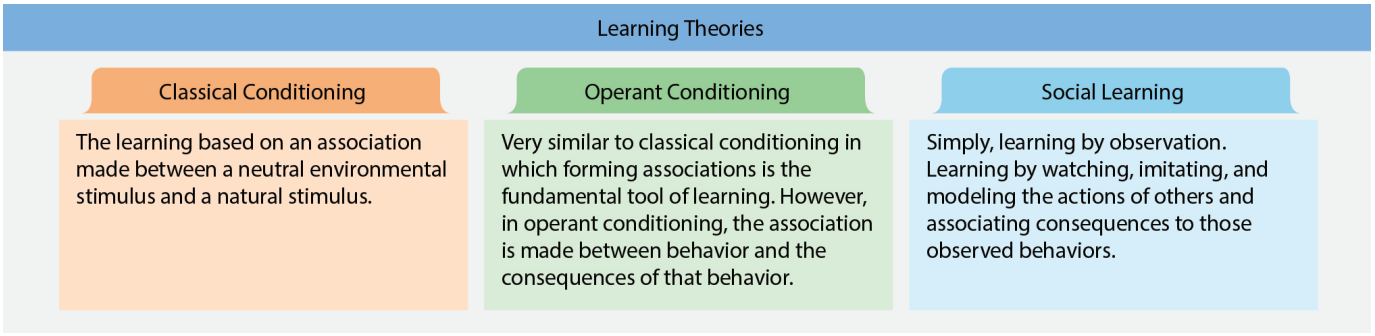

Figure 3-2. *Learning theories of psychology include classical conditioning, operant conditioning, and social learning.*

Classical conditioning is learning based on an association made between a neutral environmental stimulus and a natural stimulus. For example, the Russian psychologist Ivan Pavlov discovered that a dog could be trained to associate the sound of a beating metronome with being fed. Pavlov would start the metronome before presenting the dog with food. Over time, the dog learned to associate the unique sound with receiving food and, as a result, the dog would physically respond to only the sound of the metronome. Today, this experiment is commonly referred to as Pavlov's Dog.

Operant conditioning is very similar to classical conditioning in which forming associations is the fundamental tool of learning. However, in operant conditioning, the association is made between behavior and the consequences of that behavior. In this learning method, a positive behavior creates a positive consequence; a negative behavior creates a negative consequence. The learner then makes an association between behaviors and consequences and then predicts that future behaviors will result in similar consequences.

Social learning is simply learning by observation. Psychologist Albert Bandura's Social Learning Theory suggests, basically, that we all learn from each other. Learning occurs by observing the actions of those around us, imitating those actions, and finally modeling those actions ourselves that others around us may then observe, effectively perpetuating the learning process through continued social interactions. Bandura's theory states that there are four stages associated to social learning:

1. Attention—the ability of the observer to pay attention to others around him or her in order to learn.

2. Retention—the ability to remember an observed behavior to later repeat that behavior.

3. Reproduction—the act of producing a previously observed behavior. This may require additional skills beyond what was initially observed.

4. Motivation—the reason to reproduce an observed behavior.

Various branches of learning theory are used in formal training programs to improve and accelerate the learning process. Key concepts such as desired learning outcomes, objectives of the training, and depth of training also apply. When properly integrated, learning principles can be useful to aviation instructors and developers of instructional programs for both pilots and AMTs.

Many psychologists and educators have attempted to explain how people learn. While variations abound, modern learning theories grew out of two concepts of how people learn: behaviorism and cognitive theory.

Behaviorism

Behaviorism explains animal and human behavior entirely in terms of observable and measurable responses to stimuli. Behaviorism was introduced in the twentieth century and its followers believed all human behavior is conditioned more or less by events in the environment. Thus, human behavior can be predicted based on past rewards and punishments. Classic behaviorist theory in education stressed a system of rewards and punishment or the "carrot and stick" approach to learning. In modern education circles, behaviorism stresses the importance of having a particular form of behavior positively reinforced by someone (other than the learner) who shapes or controls what is learned. In aviation training, the instructor provides the reinforcement.

Today, behaviorism is now used more to break unwanted behaviors, such as smoking, than in teaching. The popularity of behaviorism has waned due to research that indicates learning is a much more complex process than a response to stimuli. Humans, far from being passive products of experience, are always actively interacting with the environment.

Cognitive Theory

Cognitive theory focuses on what is going on inside the mind. It is more concerned with cognition (the process of thinking and learning)—knowing, perceiving, problem-solving, decision-making, awareness, and related intellectual activities—than with stimulus and response. Learning is not just a change in behavior; it is a change in the way a learner thinks, understands, or feels. Theories based on cognition are concerned with the mental events of the learner. Much of the recent psychological thinking and experimentation in education includes some facets of the cognitive theory.

Theories of cognitive learning were established by psychologists and educators such as John Dewey, Jean Piaget, Benjamin Bloom, and Jerome Bruner. *[Figure 3-3]* There have been many interpretations of the research data dealing with cognitive theories. This has led to many different models for learning as well as some associated catch phrases.

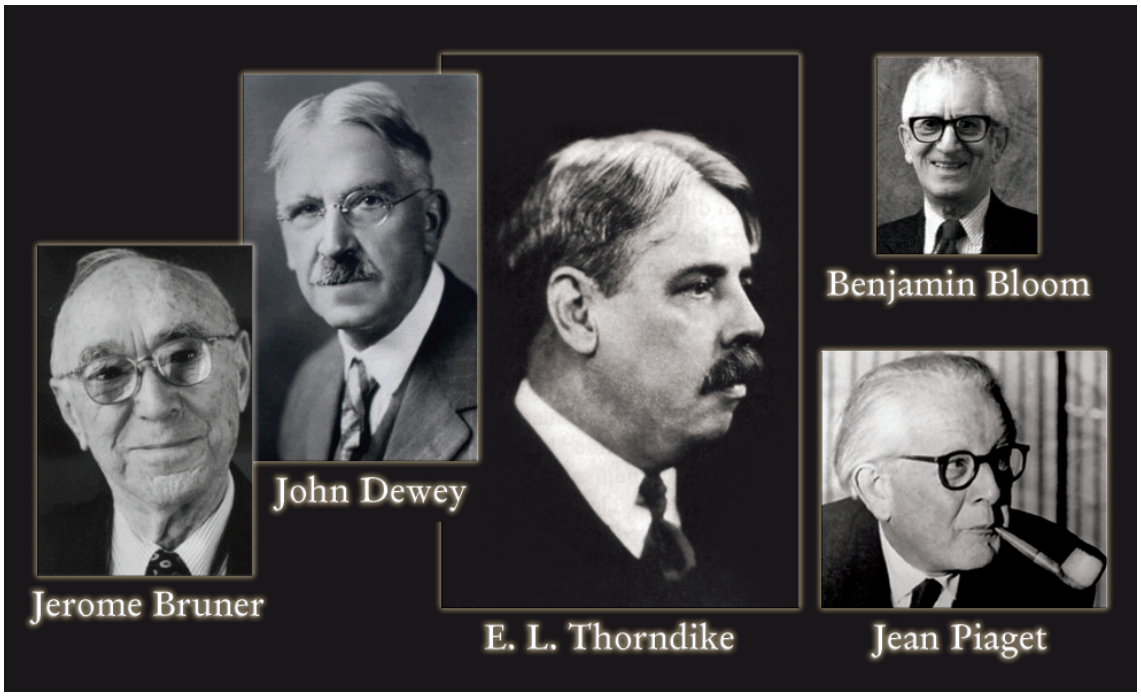

Figure 3-3. *Psychologists and educators who established the theories of cognitive learning.*

For example, educator, psychologist, and philosopher, John Dewey introduced the concept "reflective thought." Dewey believed learning improves to the degree that it arises out of the process of reflection. Over the years, terminology describing reflection has spawned a host of synonyms, such as "critical thinking," "problem-solving," and "higher level thought."

For Dewey, the concept of reflective thought carried deep meaning. He saw reflection as a process that moves a learner from one experience into the next with deeper understanding of its relationships with and connections to other experiences and ideas. Thus, reflection leads the learner from the unclear to the clear.

Jean Piaget, who spent 50 years studying how children develop intellectually, became a major figure in the school of cognitive thought. His research led him to conclude there is always tension between assimilation (old ideas meeting new situations) and accommodation (changing the old ideas to meet the new situations). The resolution of this tension results in intellectual growth. Thus, humans develop cognitive skills through active interaction with the world (a basic premise of scenario-based training (SBT), discussed later in this chapter).

An American psychologist who studied with Piaget, Jerome Bruner became interested in how intellectual development related to the process of learning. His research led him to advocate learning from the known to the unknown, or from the concrete to the abstract, because humans best learn when relating new knowledge to existing knowledge. He introduced and developed the concept of the spiral curriculum, which revisits basic ideas repeatedly and builds on them in increasingly sophisticated ways as the learner matures and develops.

Consider the opening scenario with Bill and Beverly. Bill might effectively use this theory with Beverly because she arrived at her first class with a store of aviation facts. Building upon this knowledge, Bill can teach her how to keep the aircraft in straight and level flight while he reinforces what she knows about basic aerodynamics via demonstration and discussion. Since aerodynamics is a constant thread in the flight lessons, Bill is also able to employ the spiral curriculum concept in future lessons by repeatedly revisiting the basic concepts and building upon them as Beverly's skill and knowledge increase.

A group of educators led by Benjamin Bloom tried to classify the levels of thinking behaviors thought to be important in the processes of learning. *[Figure 3-4]* They wanted to classify education goals and objectives based on the assumption that abilities can be measured along a continuum from simple to complex. The result, which remains a popular framework for cognitive theory, was Bloom's Taxonomy of the Cognitive Domain. The taxonomy (a classification system according to presumed relationships) comprises six levels of intellectual behavior and progresses from the simplest to the most complex: knowledge, comprehension, application, analysis, synthesis, and evaluation. For more detailed information about the taxonomy, see Domains of Learning.

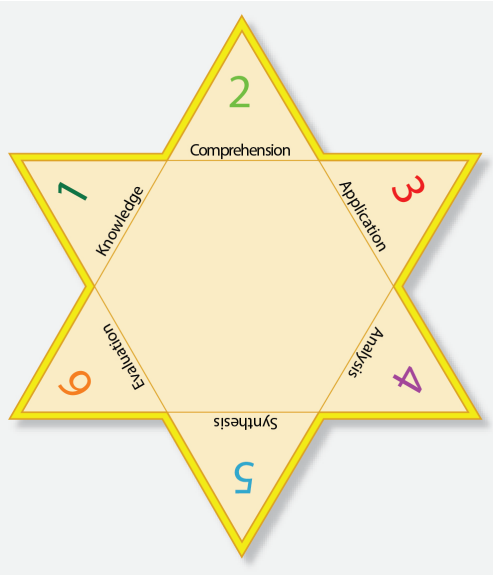

Figure 3-4. *Bloom's Taxonomy of the Cognitive Domain.*

Continued research into cognitive theory has led to theories such as information processing and constructivism. This is the basis of the organizing a lesson methods discussed in Chapter 5, The Teaching Process.

Information Processing Theory

Information processing theory uses a computer system as a model for human learning. The human brain processes incoming information, stores and retrieves it and generates responses to the information. This involves a number of cognitive processes: gathering and representing information (encoding), retaining of information, and retrieving the information when needed.

This learning system has limitations and needs to be operated properly. A computer gets input from a keyboard, mouse, etc., whereas the human brain gets input from the senses of sight, hearing, touch, taste, and smell. The amount of sensory input the brain receives per second ranges from thousands to millions of bits of information according to various theories. Regardless of the number, that is a lot of information for the brain to track and process.

One way the brain deals with all this information is to let many of the habitual and routine things go unnoticed. For example, a pilot who uses the rudder when entering a turn is usually unaware of pressing the pedal, even though it involves moving a leg, exerting pressure on the pedal, etc. The human unconscious takes charge, leaving conscious thought processes free to deal with issues that are not habitual.

Since information processing theorists approach learning primarily through a study of memory, this learning concept is revisited during the discussion of memory.

Constructivism

A derivative of cognitive theory, constructivism is a philosophy of learning that holds that learners do not acquire knowledge and skills passively but actively build or construct them based on their experiences. As implied by its name, constructivism emphasizes the constructing or building that goes on during the learning process. Therefore, it creates a learner-centered environment in which they assume responsibility for their own learning.

According to constructivism, humans construct a unique mental image by combining preexisting information with the information received from sense organs. Learning is the result of matching new information against this preexisting information and integrating it into meaningful connections. In constructivist thinking, learners are given more latitude to become effective problem solvers, identifying and evaluating problems, as well as deciphering ways in which to transfer their learning to these problems, all of which foster critical thinking skills. While the learner is at the center of the process, an experienced teacher is necessary to guide them through the information jungle. Constructivism techniques are good for some types of learning, some situations, and some individuals, but not all. This school of thought also encourages teaching learners how to use what are known as the higher order thinking skills (HOTS) from Bloom's Taxonomy and training based on problems or scenarios. Constructivism is the basis for several of the training delivery methods covered in Chapter 5, The Teaching Process.

Higher Order Thinking Skills (HOTS)

The constructivist theory of learning explains and supports the learning of HOTS, which is commonly called aeronautical decision-making (ADM) in aviation. HOTS lie in the last three levels on Bloom's Taxonomy of Learning: analysis, synthesis, and evaluation skills. Teaching the higher level thinking skills which are essential to judgment, decision-making, and critical thinking is important to aviation because a common thread in aviation accidents is the absence of higher order thinking skills (see Appendix E).

HOTS are taught like other cognitive skills, from simple to complex and from concrete to abstract. To teach HOTS effectively involves strategies and methods that include (1) using problem-based learning (PBL) instruction, (2) authentic problems, (3) real-world problems, (4) learner-centered learning, (5) active learning, (6) cooperative learning, and (7) customized instruction to meet the individual learner's needs. These strategies engage the learner in some form of mental activity, have the learner examine that mental activity and select the best solution, and challenge the learner to explore other ways to accomplish the task or the problem.

It should be remembered that critical thinking skills should be taught in the context of subject matter. Learners progress from simple to complex; therefore, they need some information before they can think about a subject beyond rote learning. For example, knowing that compliance with the weight and balance limits of any aircraft is critical to flight safety may not help an aviation learner interpret weight and balance charts unless he or she also knows something about the concept of a center of gravity.

If the learner does not yet have much subject matter knowledge, they can draw on past experiences to gain entry into complex concepts. For example, most learners probably played on a seesaw during their childhood. Thus, they have a basic experience of how weight and balance works around a center of gravity.

Additionally, HOTS should be emphasized throughout a program of study for best results. For aviation, this means HOTS should be taught in the initial pilot training program and in every subsequent pilot training program. Instructors need to teach the cognitive skills used in problem-solving until these techniques become automated and transferable to new situations or problems. Cognitive research has shown the learning of HOTS is not a change in observable behavior but the construction of meaning from experience.

Scenario-Based Training (SBT)

At the heart of HOTS lies scenario-based training (SBT) which is an example of the PBL instructional method and facilitates the enhancement of learning and the development and transference of thinking skills. SBT provides more realistic decision-making opportunities because it presents tasks in an operational environment; it correlates new information with previous knowledge, and introduces new information in a realistic context.

SBT is a training system that uses a structured script of "real-world" scenarios to address flight-training objectives in an operational environment. Such training can include initial training, transition training, upgrade training, recurrent training, and special training.

The instructor should adapt the scenarios to the aircraft, its specific flight characteristics and the likely flight environment, and should always require the learner to make real-time decisions in a realistic setting. The scenarios should always be planned and led by the learner (with the exception of the first flight or two or until the learner has developed the necessary skills).

SBT not only meets the challenge of teaching aeronautical knowledge to the application level of learning, but also enables the instructor to teach the underlying HOTS needed to improve ADM. The best use of scenarios draws the learner into formulating possible solutions, evaluating the possible solutions, deciding on a solution, judging the appropriateness of that decision and finally, reflecting on the mental process used in solving the problem. It causes the learner to consider whether the decision led to the best possible outcome and challenges the learner to consider other solutions.

SBT scenarios help learners better understand the decisions they have to make and also helps focus the learner on the decisions and consequences involved. It is being used to train people in everything from emergency response to hotel management. The strength of SBT lies in helping the learner gain a deeper understanding of the information and in the learner improving his or her ability to recall the information. This goal is reached when the material is presented as an authentic problem in a situated environment that allows the learner to "make meaning" of the information based on his or her past experience and personal interpretation.

SBT has become one of the primary methods to teach today's aviation learners how to make good aeronautical decisions which in turn enhances the safety of all aviation related activities. For information on how to create an SBT lesson, refer to Chapter 5, The Teaching Process, and for how to incorporate SBT into a training syllabus, refer to Chapter 7, Planning Instructional Activity.

Perceptions

Initially, all learning comes from perceptions, which are directed to the brain by one or more of the five senses: sight, hearing, touch, smell, and taste. Psychologists have also found that learning occurs most rapidly when information is received through more than one sense. *[Figure 3-5]*

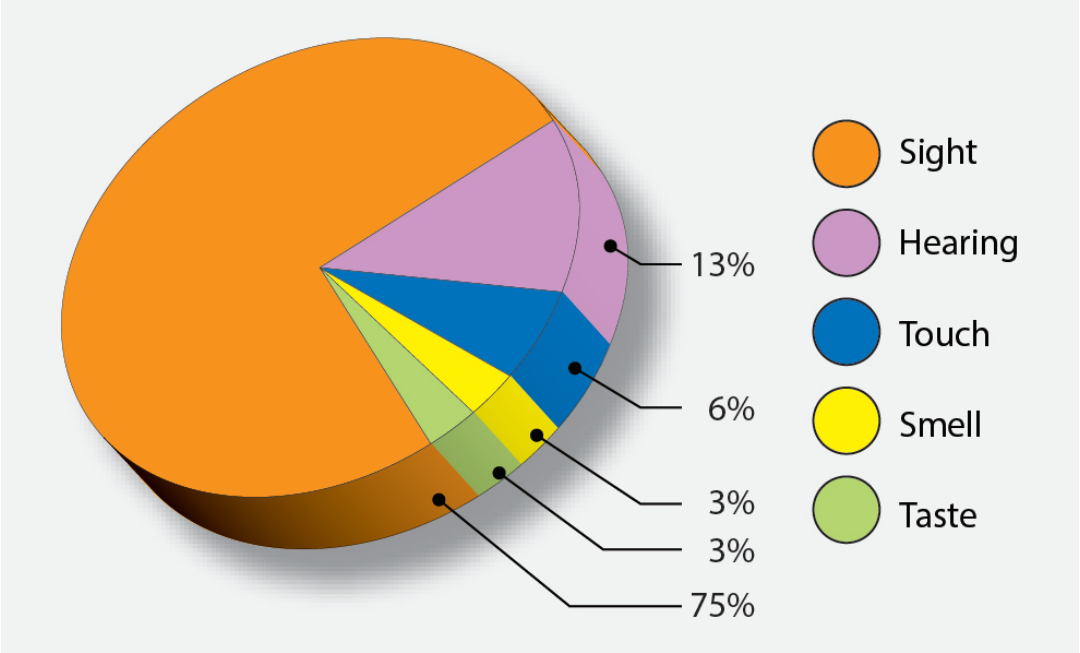

Figure 3-5. *Most learning occurs through sight, but the combination of sight and hearing accounts for about 88 percent of all perception.*

Perception involves more than the reception of stimuli from the five senses; it also involves a person giving meaning to sensations. People base their actions on the way they believe things to be. The experienced AMT, for example, perceives an engine malfunction quite differently than does an inexperienced learner. This occurs because the beginning aviation learner is overwhelmed by stimuli and often focuses on meaningless things, thus missing key information. It is important for the instructor to direct trainee's perceptions initially so that the learner detects and perceives relevant information.

Real meaning comes only from within a person, even though the perceptions, which evoke these meanings, result from external stimuli. The meanings, which are derived from perceptions, are influenced not only by the individual's experience, but also by many other factors. Knowledge of the factors that affect the perceptual process is very important to the aviation instructor because perceptions are the basis of all learning.

Factors that Affect Perception

Both internal and external factors affect an individual's ability to perceive:

- Physical organism
- Goals and values
- Self-concept
- Time and opportunity
- Element of threat

Physical Organization

The physical organism provides individuals with the perceptual apparatus for sensing the world around them. Pilots, for example, need to see, hear, feel, and respond adequately while they are in the air.

Goals and Values

Perceptions depend on one's values and goals. Every experience and sensation, which is funneled into one's central nervous system, is colored by the individual's own beliefs and value structures. Spectators at a ball game may see an infraction or foul differently depending on which team they support. The values of the learner are important for the instructor to know, because this knowledge assists in predicting how he or she interprets experiences and instructions.

Goals are also a product of one's value structure. Things that are more highly valued and cherished are pursued; those accorded less value and importance are not sought after.

Self-Concept

Self-concept is a powerful determinant in learning. A learner's self-image, described in such terms as "confident" or "insecure," has a great influence on the total perceptual process. If a learner's experiences tend to support a favorable self-image, the learner tends to remain receptive to subsequent experiences. If a learner has negative experiences, which tend to contradict self-concept, there is a tendency to reject additional training.

A negative self-concept inhibits the perceptual processes by introducing psychological barriers, which tend to keep the learner from perceiving. They may also inhibit the ability to properly implement what is perceived. That is, self-concept affects the ability to actually perform or do things. Learners who view themselves positively, on the other hand, are less defensive and more receptive to new experiences, instructions, and demonstrations.

Time and Opportunity

It takes time and opportunity to perceive. Learning some things depends on other past perceptions and on the availability of time to sense and relate these new things to the earlier perceptions. Thus, proper sequence and time are necessary.

A learner could probably stall an aircraft on the first attempt, regardless of previous experience. Stall recovery cannot really be learned, however, unless some experience in normal flight has been acquired. Even with such experience, time and practice are needed to relate the new sensations and experiences associated with stall recovery in order to develop a perception of the stall. In general, lengthening an experience and increasing its frequency are the most obvious ways to speed up learning, although this is not always effective. Many factors, in addition to the length and frequency of training periods, affect the rate of learning. The effectiveness of the use of a properly planned training syllabus is proportional to the consideration it gives to the time and opportunity factor in perception.

Element of Threat

The element of threat does not promote effective learning. In fact, fear adversely affects perception by narrowing the perceptual field. Confronted with threat, learners tend to limit their attention to the threatening object or condition. The field of vision is reduced, for example, when an individual is frightened and all the perceptual faculties are focused on the thing that has generated fear.

Flight instruction provides many clear examples of this. During the initial practice of steep turns, Beverly may focus her attention on the altimeter and completely disregard outside visual references. Anything Bill does that is interpreted as threatening makes Beverly less able to accept the experience Bill is trying to provide. It adversely affects all her physical, emotional, and mental faculties.

Learning is a psychological process, not necessarily a logical one. Trying to frighten a learner through threats of unsatisfactory reports or reprisals may seem logical, but is not effective psychologically. The effective instructor organizes teaching to fit the psychological needs of the learner. If a situation seems overwhelming, the learner feels unable to handle all of the factors involved; a threat exists. As long as the learner feels capable of coping with a situation, each new experience is viewed as a challenge.

A good instructor recognizes that behavior is directly influenced by the way a learner perceives, and perception is affected by all of these factors. Therefore, it is important for the instructor to facilitate the learning process by avoiding any actions which may inhibit or prevent the attainment of teaching goals. Teaching is consistently effective only when those factors that influence perception are recognized and taken into account.

Insight

Insight involves the grouping of perceptions into meaningful wholes. Creating insight is one of the instructor's major responsibilities. To ensure that this occurs, it is essential to keep each learner constantly receptive to new experiences and to help them understand how each piece relates to all other pieces of the total pattern of the task.

For example, during straight-and-level flight in an aircraft with a fixed-pitch propeller, the revolutions per minute (rpm) increase when the throttle is opened and decrease when it is closed. On the other hand, rpm changes can also result from changes in aircraft pitch attitude without changes in power setting. Obviously, engine speed, power setting, airspeed, and aircraft attitude are all related.

True learning requires an understanding of how each factor may affect all of the others and, at the same time, knowledge of how a change in any one of them may affect all of the others. This mental relating and grouping of associated perceptions is called insight.

Insight almost always occurs eventually, whether or not instruction is provided. For this reason, it is possible for a person to become an electrician by trial and error, just as one may become a lawyer by reading law. Instruction, however, speeds this learning process by teaching the relationship of perceptions as they occur, thus promoting the development of the learner's insight.

As perceptions increase in number, the learner develops insight by assembling them into larger blocks. As a result, learning becomes more meaningful and more permanent. Forgetting is less of a problem when there are more anchor points for tying insights together. It is a major responsibility of the instructor to organize demonstrations and explanations, and to direct practice so that the learner has better opportunities to understand the interrelationship of the many kinds of experiences that have been perceived. Pointing out the relationships as they occur, providing a secure and nonthreatening environment in which to learn, and helping the learner acquire and maintain a favorable self-concept are key steps in fostering the development of insight.

Acquiring Knowledge

Part of an aviation instructor's job is helping learners acquire knowledge. In this context, knowledge refers to information that humans are consciously aware of and can articulate. For example, knowledge of the fuel capacity of a particular aircraft, understanding how an internal combustion engine works, and the ability to determine the weight and balance of an aircraft are examples of knowledge.

Figure 3-6 shows the three phases of knowledge, a progression of how learners acquire knowledge. Some practical considerations about learning new knowledge and instructor actions that help learners acquire knowledge are summarized.

Memorization

A learner's first attempt to acquire knowledge about a new topic amounts to memorizing facts about steps in a procedure. For example, when Beverly is learning to use an altimeter, she may have memorized that the knob on the instrument is used to dial the current barometric pressure and that this number should be obtained from the recorded broadcast and set prior to flight.

Memorizing facts and steps has an advantage: it allows learners to get started quickly. For example, as soon as Beverly memorizes the purpose of the knob on the altimeter and the procedure for obtaining the current barometric pressure, she is able to properly configure the instrument for flight.

The limitations of memorization become apparent when a learner is asked to solve a problem or provide an explanation of something that is not covered by the newly acquired knowledge. For example, when asked whether she would rather have the altimeter mistakenly set too high or too low when flying in mountainous terrain, Beverly may not have an answer.

Understanding

A more experienced pilot can answer the altimeter question because she or he understands the ramifications of the question. Understanding, or the ability to notice similarities and make associations between the facts and procedural steps learned, is an important next stage in the knowledge acquisition process. At this stage, the learner begins to organize knowledge in useful ways and a collection of memorized facts gives way to understanding.

Understanding develops when learners begin to organize known facts and steps into coherent groups that come together to form an understanding of how a thing or a process works. For example, after learning to adjust the mixture control in cruise flight, Beverly learns that combustion requires a certain mixture of fuel and air, and that air becomes less dense as altitude increases.

Figure 3-6. *A learner acquires knowledge through memorization, understanding, and application.*

Combining these two ideas, she now understands the purpose of the mixture control is to keep these two quantities in balance as the aircraft changes altitude. "Mental model" or self-explanation is often used to refer to an organized collection of ideas that forms a learner's understanding of a thing or process.

The advantages of possessing this type of understanding include the following:

1. The learner is no longer limited to answering questions that match the memorized facts. For example, armed with the understanding of the mixture control, Beverly may now be able to produce answers to more challenging questions, such as what would happen if the mixture were set too rich or too lean.

2. Learners who understand a process have an easier time mastering variations of the processes, such as unfamiliar aircraft, new avionics systems, and unfamiliar airport procedures.

3. Understanding shared between people allows them to communicate more efficiently. For example, an experienced pilot might mention to an experienced mechanic that a magneto ran a bit rough during an engine run-up. This brief communication triggers access to a wealth of knowledge in the mind of the mechanic who instantly knows what to do.

4. Learners who understand the purpose behind procedure steps are better able to remember the procedure steps later, or reconstruct them when they are forgotten.

Mental models evolve as learners take in new information. For example, Bill could ask Beverly why flying with an inappropriate mixture setting is bad. A learner whose understanding includes knowledge about spark plugs and carbon deposits might answer correctly. If this same learner's understanding later extends to include knowledge about thermal efficiency and the stoichiometric equation for the combustion of gasoline, the explanations are likely to become much more sophisticated. No individual's understanding of anything is ever "complete."

Concept Learning

Concept learning is based on the assumption that humans tend to group objects, events, ideas, people, etc., that share one or more major attributes that set them apart. It also involves discrimination between types of things or ideas inside or outside of a concept set. By grouping information into concepts, humans reduce the complexities of life and create manageable categories. Although many theories about concept learning exist, categorization has always been a central aspect.

Concept learning enhances understanding when individuals formulate generalized concepts from particular facts or steps. Generalized concepts are more powerful than facts because instead of literally describing one thing, they describe many things at once.

For example, a new flight learner who sees several examples of weight-shift control (WSC) aircraft may formulate a category for WSC aircraft based on the wing, which is large and fabric covered. The power of the category becomes obvious when the learner sees a sport plane. Because of the similar wing, he or she immediately categorizes it as an ultralight and ascribes many of the properties of ultralight aircraft to the sport plane. In this way, the learner has used a generalized concept to begin understanding something new.

Most learners exhibit a natural tendency to categorize and become adept at recognizing members of most any category they create. If something is encountered that does not fit into a category, these learners formulate a new category or revise the definitions of existing categories. In the above example, the learner eventually needs to revise the category of ultralight to light-sport aircraft which encompasses both types of aircraft. Therefore, an important part of the learning process is continual revision of the categories used when learners encounter new things or exceptions to things previously catalogued.

Another type of generalization is a schema (the cognitive framework that helps people organize and interpret information). Schemas can be revised by any new information and are useful because they allow people to take shortcuts in interpreting a vast amount of information.

Humans form schemas when they notice reoccurring patterns in things frequently observed or done. Schemas help learners interpret things they observe by priming them to expect certain elements that match the schema. For example, schemas demonstrate why an experienced pilot is able to listen to and read back a lengthy departure clearance issued by air traffic control (ATC). Beginning flight learners often remember the controller's use of the words "the" and "and" and fail to note more important words that describe assigned altitudes or radio frequencies. The experienced pilot is successful because he or she possesses a schema for this type of event and knows in advance that the clearance contains five key pieces of information. While listening to the clearance, the pilot anticipates and is primed to capture those five things.

Similarly, learners create schemas for preflight inspection procedures and procedures required to operate advanced flight deck systems such as autopilots or multifunction displays. As with categories, humans continuously learn new schemas and revise old ones to accommodate new things as they continue to learn. While schemas help humans deal with information, they can also make it difficult to retain new information that does not conform to established schemas.

Thorndike and the Laws of Learning

One of the pioneers of educational psychology, E.L. Thorndike formulated three laws of learning in the early 20th century. *[Figure 3-7]* These laws are universally accepted and apply to all kinds of learning: the law of readiness, the law of exercise, and the law of effect. Since Thorndike set down his laws, three more have been added: the law of primacy, the law of intensity, and the law of recency.

Readiness

The basic needs of the learner need to be satisfied before he or she is ready or capable of learning (see Chapter 2, Human Behavior). The instructor can do little to motivate the learner if these needs have not been met. This means the individual should want to learn the task being presented and possesses the requisite knowledge and skill. In SBT, the instructor attempts to make the task as meaningful as possible and to keep it within the learner's capabilities.

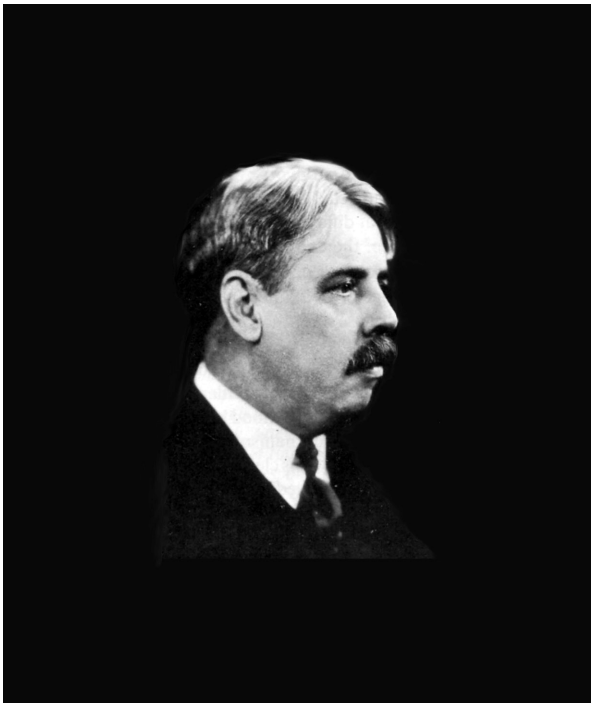

Figure 3-7. *E. L. Thorndike (1874–1949).*

Learners best acquire new knowledge when they see a clear reason for doing so, often show a strong interest in learning what they believe they need to know next, and tend to set aside things for which they see no immediate need. For example, beginning flight learners commonly ignore the flight instructor's suggestion to use the trim control. These learners believe the control yoke is an adequate way to manipulate the aircraft's control surfaces. Later in training, when they need to divert their attention away from the controls to other tasks, they realize the importance of trim.

Instructors can take two steps to keep their learners in a state of readiness to learn. First, instructors should communicate a clear set of objectives to the learner and relate each new topic to those objectives. Second, instructors should introduce topics in a logical order and leave learners with a need to learn the next topic. The development and use of a well-designed curriculum accomplish this goal.

Readiness to learn also involves what is called the "teachable moment" or a moment of educational opportunity when a person is particularly responsive to being taught something. One of the most important skills to develop as an instructor is the ability to recognize and capitalize on "teachable moments" in aviation training. An instructor can find or create teachable moments in flight training activity whether it is pattern work, air work in the local practice area, cross-country, flight review, or instrument proficiency check.

Teachable moments present opportunities to convey information in a way that is relevant, effective, and memorable to the learner. They occur when a learner can clearly see how specific information or skills can be used in the real-world.

For example, while on final approach several deer cross the runway. Bill capitalizes on this teachable moment to stress the importance of always being ready to perform a go-around.

Effect

Learning involves the formation of connections, and connections are strengthened or weakened according to the law of effect. The law states that behaviors that lead to satisfying outcomes are likely to be repeated whereas behaviors that lead to undesired outcomes are less likely to recur. For example, if Bill teaches landings to Beverly during the first flight, she is likely to feel inferior and be frustrated, which weakens the intended learning connection.

The learner needs to have success in order to have more success in the future. It is important for the instructor to create situations designed to promote success. Positive training experiences are more apt to lead to success and motivate the learner, while negative training experiences might stimulate forgetfulness or avoidance. When presented correctly, SBT provides immediate positive experiences in terms of real-world applications.

To keep learning pleasant and to maintain motivation, an instructor should make positive comments about the learner's progress before discussing areas that need improving. Flight instructors have an opportunity to do this during the flight debriefing. For example, Bill praises Beverly on her aircraft control during all phases of flight but offers constructive comments on how to better maintain the runway centerline during landings.

Exercise

Connections are strengthened with practice and weakened when practice is discontinued, which reflects the adage "use it or lose it." The learner needs to practice what has been taught in order to understand and remember the learning. Practice strengthens the learning connection; disuse weakens it. Exercise is most meaningful and effective when a skill is learned within the context of a real-world application.

Primacy

When an error occurs pouring a concrete foundation for a building, undoing and correcting the job becomes much more difficult than doing it right the first time. Primacy in teaching and learning, what is learned first, often creates a strong, almost unshakable impression and underlies the reason an instructor needs to teach correctly the first time.

Also, if the task is learned in isolation, it is not initially applied to the overall performance, or if it needs to be relearned, the process can be confusing and time consuming. The first experience should be positive, functional, and lay the correct foundation for all that is to follow.

Intensity

Immediate, exciting, or dramatic learning connected to a real situation teaches a learner more than a routine or boring experience. Real-world applications (scenarios) that integrate procedures and tasks the learner is capable of understanding make a vivid impression, and he or she is least likely to forget the experience. For example, using realistic scenarios has been shown to be effective in the development of proficiency in flight maneuvers, tasks, and single-pilot resource management (SRM) skills.

Recency

The principle of recency states that things most recently learned are best remembered. Conversely, the further a learner is removed in time from a new fact or understanding, the more difficult it is to remember. For example, it is easy for a learner to recall a torque value used a few minutes earlier, but it is more difficult or even impossible to remember a value last studied or used further back in time.

Instructors recognize the principle of recency when they carefully plan a summary for a ground school lesson, a shop period, or a postflight critique. The instructor repeats, restates, or reemphasizes important points at the end of a lesson to help the learner remember them. The principle of recency often determines the sequence of lectures within a course of instruction.

In SBT, the closer the training or learning time is to the time of the actual scenario, the more apt the learner is to perform successfully. This law is most effectively addressed by making the training experience as much like the scenario as possible.

Domains of Learning

As mentioned during the discussion of Cognitive Theory, Dr. Bloom played a central role in transforming the field of educational psychology. Interested in what and how people learn, he proposed a framework to help understand the major areas of learning and thinking. He first classified them into three large groups *[Figure 3-8]* called the domains of learning:

- Cognitive (thinking)
- Affective (feeling)
- Psychomotor (doing)

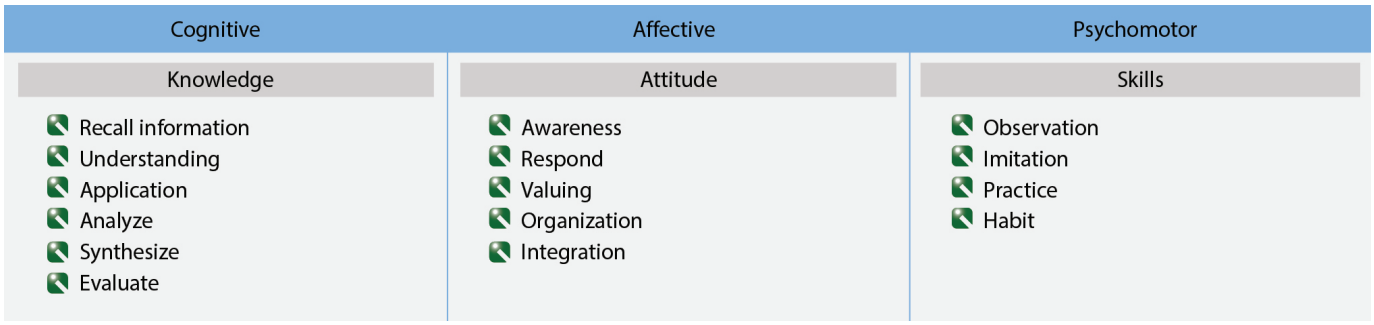

Figure 3-8. *An overview of the three learning domains.*

Cognitive Domain

The cognitive domain is one of the best known educational domains. It includes remembering specific facts (content knowledge) and concepts that help develop intellectual abilities and skills. There are six major categories, or levels, starting from the simplest behavior (recalling facts) to the most complex (evaluation). *[Figure 3-9]*

Competence		Skills Demonstrated	Example
I	Knowledge: remembering information	Define, identify, label, state, list, match, select	1. State the standard temperature at sea level. 2. Define a logbook entry.
II	Comprehension: explaining the meaning of information	Describe, generalize, paraphrase, summarize, estimate, discuss	1. In one sentence explain why aviation uses a standard temperature. 2. Describe why a log entry is required by the FAA.
III	Application: using abstractions in concrete situation	Determine, chart, implement, prepare, solve, use, develop, explain, apply, relate, instruct, show, teaches	1. Using a standard lapse rate, determine what the temperature would be at a pressure altitude of 4000'. 2. Determine when a logbook entry is required.
IV	Analysis: breaking down a whole into component parts	Points out, differentiate distinguish, examine discriminate, compare, outline, prioritize, recognize, subdivide	1. Compare what the different temperatures would be at certain pressure altitudes based on the standard lapse rate. 2. Determine information required for logbook entry.
V	Synthesis: putting parts together to form a new and integrated whole	Create, design, plan, organize, generate, write, adapt, compare, formulate, devise, model, revise, incorporate	1. Generate a chart depicting temperatures for altitudes up to 12,000'. 2. Write a logbook entry for an oil change.
VI	Evaluation: making judgments about the merits of ideas, materials, or phenomena	Appraise, critique, judge, weigh, evaluate, select, compare and contrast, defend, interpret, support	1. Evaluate the importance of this information for a pilot. 2. Evaluate the necessity of keeping logbook entries.

Figure 3-9. *The six major levels of Bloom's Taxonomy of the Cognitive Domain with types of behavior with objectives.*

The four practical learning levels are rote, understanding, application, and correlation. *[Figure 3-10]* The lowest level is the ability to repeat something which one has been taught, without understanding or being able to apply what has been learned. This is referred to as rote learning. The fact level is a single concept. The key verbs which describe or measure this activity are words such as define, identify, and label. The comprehension or understanding level puts two or more concepts together and uses verbs such as describe, estimate, or explain. The application level puts two or more concepts together to form something new. Typical verbs at this level include "determine," "develop," and "solve."

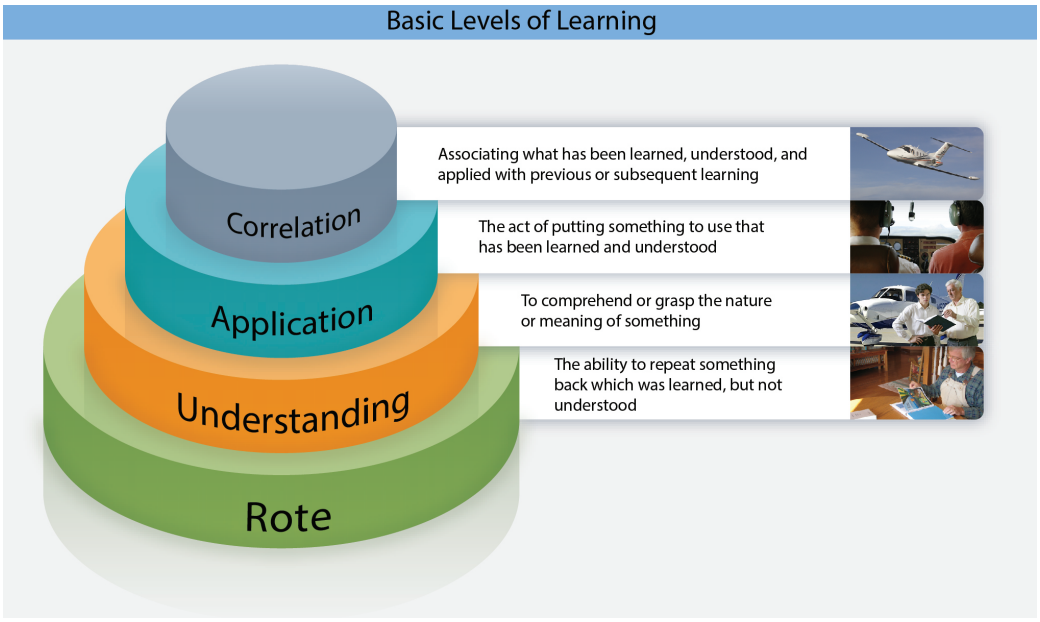

Figure 3-10. *Learning is progressive and occurs at several basic levels.*

For example, Bill may explain the procedure for entering a level, left turn to Beverly. The procedure includes several steps: (1) visually clear the area, (2) add a slight amount of power to maintain airspeed, (3) apply aileron control pressure to the left, (4) add sufficient rudder pressure in the direction of the turn to avoid slipping and skidding, and (5) increase back pressure to maintain altitude. When Beverly verbally repeats this instruction, she has learned the procedure by rote. This will not be very useful to her if there is never an opportunity to make a turn in flight, or if she has no knowledge of the function of aircraft controls.

With proper instruction on the effect and use of the flight controls, and experience in controlling the aircraft during straight-and-level flight, Beverly can consolidate old and new perceptions into an insight on how to make a turn. At this point, she has developed an understanding of the procedure for turning the aircraft in flight. This understanding is basic to effective learning, but may not necessarily enable her to make a correct turn on the first attempt.

When Beverly understands the procedure for entering a turn, has had turns demonstrated, and has practiced turn entries until consistency has been achieved, she has developed the skill to apply what has been learned. This is a major level of learning, and one at which the instructor is too often willing to stop. Discontinuing instruction on turn entries at this point and directing subsequent instruction exclusively to other elements of piloting performance is characteristic of piecemeal instruction, which is usually inefficient.

The correlation level of learning, which should be the objective of aviation instruction, is that level at which the individual becomes able to associate an element which has been taught with other segments or blocks of learning. The other segments may be items or skills previously learned or new tasks to be undertaken in the future. When Beverly has achieved this level of learning in turn entries, for example, she has developed the ability to correlate the elements of turn entries with the performance in traffic patterns.

The three higher levels of the cognitive domain include analysis, synthesis and evaluation (the HOTS level previously mentioned in the learning theory section). The analysis level involves breaking the information into its component parts, examining, and trying to understand the information in order to develop conclusions, make inferences, and/or find evidence to support generalizations. This level uses such verbs as points out, differentiate, distinguish, examine, discriminate, compare, outline, prioritize, recognize, or subdivide.

Synthesis involves putting parts together to form a new and integrated whole. Typical verbs for this level include create, design, plan, organize, generate, write, adapt, compare, formulate, devise, model, revise, or incorporate. The final level in the taxonomy is evaluation and involves making judgments about the merits of ideas, materials, or phenomena. The following example demonstrates the difference between learning on the first three levels versus learning critical thinking skills.

Bill provides a detailed explanation on how to control for wind drift. The explanation includes a thorough coverage of heading, speed, angle of bank, altitude, terrain, and wind direction plus velocity. The explanation is followed by a demonstration and repeated practice of a specific flight maneuver, such as turns around a point or S-turns across the road until the maneuver can be consistently accomplished in a safe and effective manner within a specified limit of heading, altitude, and airspeed. At the end of this lesson, Beverly is only capable of performing the maneuver.

Then Bill asks Beverly to plan for the arrival at a specific nontowered airport. The planning should take into consideration the possible wind conditions, arrival paths, airport information and communication procedures, available runways, recommended traffic patterns, courses of action, and preparation for unexpected situations. Upon arrival at the airport, Beverly makes decisions (with guidance and feedback as necessary) to safely enter and fly the traffic pattern. This is followed by a discussion of what was done, why it was done, the consequences, and other possible courses of action and how it applies to other airports. At the end of this lesson the learner is capable of explaining the safe arrival at any nontowered airport in any wind condition.

For aviation instructors, educational objectives for the first three levels (knowledge, comprehension, and application) are generally gained as the result of attending a ground school, reading about aircraft systems, listening to a preflight briefing, or taking part in computer-based training. The highest educational objective levels in this domain (analysis, synthesis, and evaluation) can be acquired through SBT training. For example, the learner pilot understands how to correctly evaluate a flight maneuver or the maintenance learner repairs an aircraft engine. Sample questions for each level of the cognitive domain are provided in Figure 3-9.

Affective Domain

The affective domain addresses a learner's emotions toward the educational experience. It includes feelings, values, enthusiasms, motivations, and attitudes. *[Figure 3-11]* For the aviation instructor, this may mean how the individual approaches learning. Is he or she motivated to learn? Does he or she exhibit confidence in learning? Does the learner display a positive attitude towards safety and risk mitigation?

The affective domain provides a framework for teaching in five levels: awareness, response, value, organizing, and integration. In this taxonomy, the learner begins on the awareness level and is open to learning, willing to listen to the instructor. As the learner traverses the taxonomy, he or she responds by participating actively in the training, decides the value of the training, organizes the training into his or her personal belief system, and finally internalizes it.

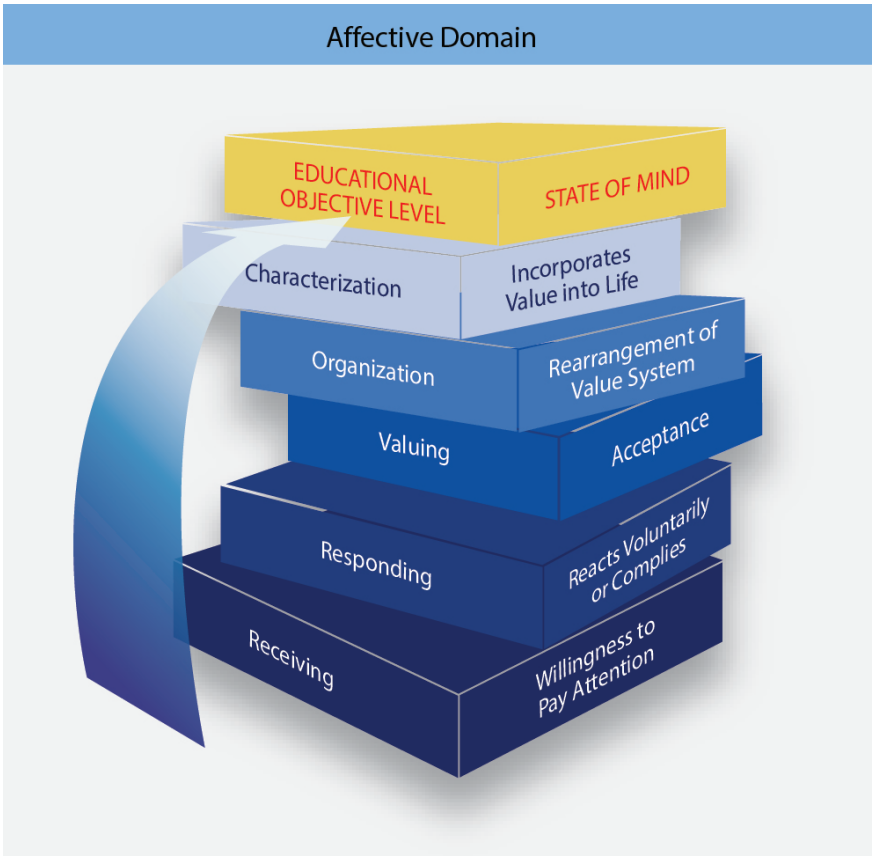

Figure 3-11. *The affective domain (attitudes, beliefs, and values) contains five educational objective levels.*

The affective domain is more difficult to measure, but motivation and enthusiasm are important components of any learning. Therefore, the aviation instructor should be acquainted with this facet of learning. Motivation is discussed in depth later in the chapter.

Psychomotor Domain

The psychomotor domain is skill based and includes physical movement, coordination, and use of the motor-skill areas. *[Figure 3-12]* Development of these skills utilizes repetitive practice and is measured in terms of speed, precision, distance, and techniques. While various examples of the psychomotor domain exist, the practical instructional levels for aviation training purposes include the following:

- Observation
- Imitation
- Practice
- Habit

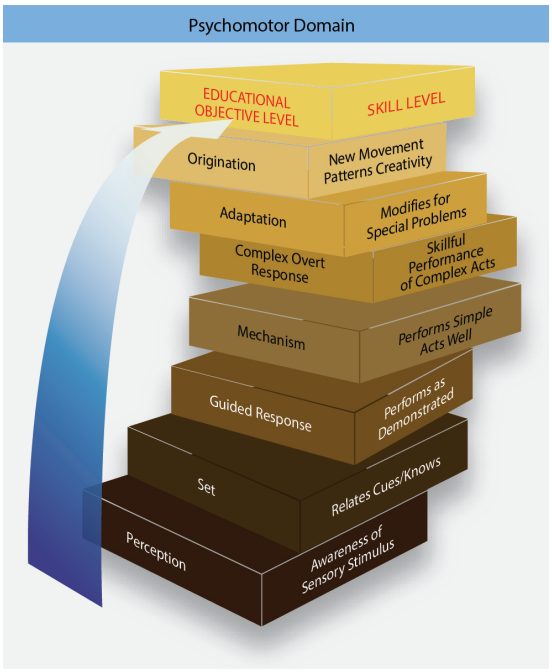

Figure 3-12. *The psychomotor domain (physical skills) consists of seven educational objective levels.*

These basic levels make up the broad instructional process, independent of the specific domain chosen and are important components of instruction when aviation instructors prepare learners for the practical test.

At the first level, the learner observes a more experienced person perform the skill. The instructor has the learner observe sequences and relationships that lead to the finished product. Observation may be supplemented by reading, watching a DVD, or computer-based training. The second level is imitation in which the learner attempts to copy the skill under the watchful eye of the instructor.

The practice level is a proficiency building experience in which the learner tries a specific activity over and over. It may be conducted by the learner without direct oversight of the instructor, such as touch-and-go landings for the flight learner who has flown a successful solo flight. The habit level is reached when the learner can perform the skill in twice the time that it takes the instructor or an expert to perform. The evaluation of ability is a performance or skill test. If a person continues to perfect a skill, it eventually becomes a skill performed at the expert level.

Skills involving the psychomotor domain include learning to fly a precision instrument approach procedure, programming a global positioning system (GPS) receiver, or using sophisticated maintenance equipment. As physical tasks and equipment become more complex, the requirement for integration of cognitive and physical skills increases.

Summary of Instructor Actions

To help learners acquire knowledge, the instructor should:

- Ask learners to recite or practice newly acquired knowledge.
- Ask questions that probe learner understanding and prompt them to think about what they have learned in different ways.
- Present opportunities for learners to apply what they know to solving problems or making decisions.
- Present learners with problems and decisions that test the limits of their knowledge.
- Demonstrate the benefits of understanding and being able to apply knowledge.
- Introduce new topics as they support the objectives of the lesson, whenever possible.

These additional levels of learning are the basis of the knowledge, attitude, and skill learning objectives commonly used in advanced qualification programs for airline training. They also can be tied to the ACS to show the level of knowledge or skill required for a particular task. A list of action verbs for the three domains shows appropriate behavioral objectives at each level. *[Figure 3-13]* Instructors who are familiar with curriculum development recognize that the action verbs are examples of performance-based objectives.

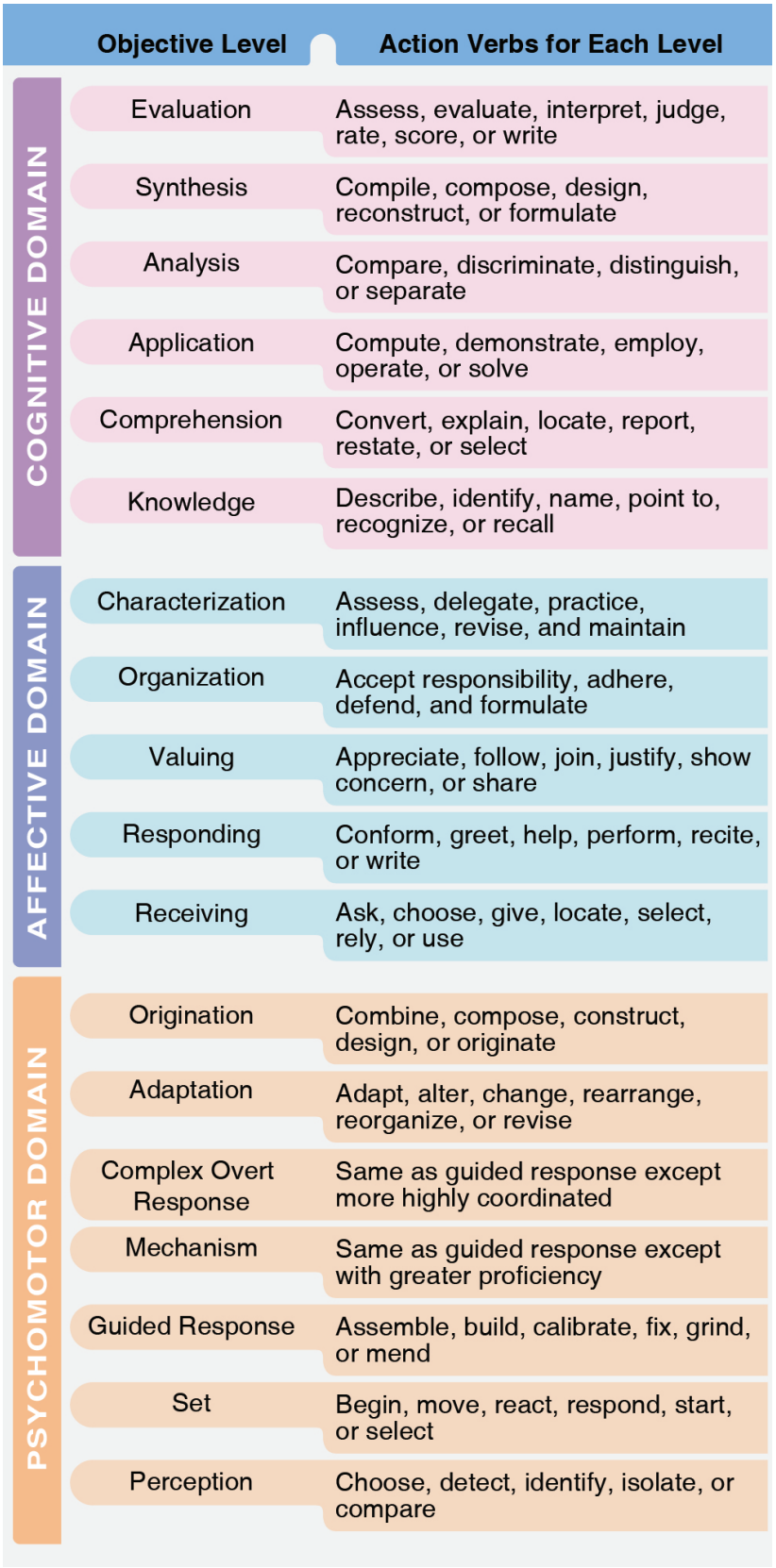

Figure 3-13. *A listing such as the one shown here is useful for development of almost any training program.*

Characteristics of Learning

The ability to learn is one of the most outstanding human characteristics. Learning occurs continuously throughout a person's lifetime. To understand how people learn, it is necessary to understand what happens to the individual during the process. In spite of numerous theories and contrasting views, psychologists generally agree there are many characteristics of learning.

Knowledge of the general characteristics of learning help an aviation instructor use them in a learning situation. If learning is a change in behavior as a result of experience, then instruction needs to include a careful and systematic creation of those experiences that promote learning. This process can be quite complex because, among other things, an individual's background strongly influences the way that person learns. To be effective, the learning situation also should be purposeful, based on experience, multifaceted, and involve an active process.

Learning Is Purposeful

Each learner sees a learning situation from a different viewpoint. Each learner is a unique individual whose past experiences affect readiness to learn and understanding of the requirements involved. For example, an instructor may give two aviation maintenance learners the assignment of learning certain inspection procedures. One learner may catch on quickly and be able to competently present the assigned material. The combination of an aviation background and future goals may enable that learner to realize the need and value of learning the procedures. A second learner's goal may only be to comply with the instructor's assignment, and may result in only minimum preparation. The responses differ because each learner acts in accordance with what he or she sees in the situation.

Most people have fairly definite ideas about what they want to do and achieve. Their goals sometimes are short term, involving a matter of days or weeks. On the other hand, their goals may be carefully planned for a career or a lifetime. Each learner has specific intentions and goals. Some may be shared by other learners. Learners learn from any activity that tends to further their goals. Their individual needs and attitudes may determine what they learn as much as what the instructor is trying to teach. In the process of learning, the goals are of paramount significance. To be effective, aviation instructors need to find ways to relate new learning to the learner's goals.

Learning Is a Result of Experience

Since learning is an individual process, the instructor cannot do it for the learner. The learner can learn only from personal experiences; therefore, learning and knowledge cannot exist apart from a person. A person's knowledge is a result of experience, and no two people have had identical experiences. Even when observing the same event, two people react differently; they learn different things from it, according to the manner in which the situation affects their individual needs. Previous experience conditions a person to respond to some things and to ignore others.

All learning is by experience, but learning takes place in different forms and in varying degrees of richness and depth. For instance, some experiences involve the whole person while others may be based only on hearing and memory. Aviation instructors are faced with the problem of providing learning experiences that are meaningful, varied, and appropriate. As an example, learners can learn to say a list of words through repeated drill, or they can learn to recite certain principles of flight by rote. However, they can make them meaningful only if they understand them well enough to apply them correctly to real situations. If an experience challenges the learners, requires involvement with feelings, thoughts, memory of past experiences, and physical activity, it is more effective than a learning experience in which all the learners have to do is commit something to memory.

It seems clear enough that the learning of a physical skill requires actual experience in performing that skill. Pilots in training learn to fly aircraft only if their experiences include flying an aircraft; AMTs in training learn to overhaul power plants only by actually performing that task. Mental habits are also learned through practice. If learners are to use sound judgment and develop decision-making skills, they need experiences that involve knowledge of general principles and require the use of judgment in solving realistic problems.

Learning Is Multifaceted

If instructors see their objective as being only to train their learners' memory and muscles, they are underestimating the potential of the teaching situation. Individuals learn much more than expected if they fully exercise their minds and feelings. The fact that these items were not included in the instructor's plan does not prevent them from influencing the learning situation.

Psychologists sometimes classify learning by types, such as verbal, conceptual, perceptual, motor, problem-solving, and emotional. Other classifications refer to intellectual skills, cognitive strategies, and attitudinal changes, along with descriptive terms like surface or deep learning. However useful these divisions may be, they are somewhat artificial. For example, a class learning to apply the scientific method of problem-solving may learn the method by trying to solve real problems. But in doing so, the class also engages in verbal learning and sensory perception at the same time. Each learner approaches the task with preconceived ideas and feelings, and for many learners, these ideas change as a result of experience. Therefore, the learning process may include verbal elements, conceptual elements, perceptual elements, emotional elements, and problem-solving elements all taking place at once. This aspect of learning will become more evident later in this handbook when lesson planning is discussed.

Learning is multifaceted in still another way. While learning the subject at hand, individuals may be learning other things as well. They may be developing attitudes about aviation—good or bad—depending on what they experience. Under a skillful instructor, they may learn self-reliance. The list is seemingly endless. This type of learning is sometimes referred to as incidental, but it may have a great impact on the total development of the learner.

Learning Is an Active Process

Learners do not soak up knowledge like a sponge absorbs water. The instructor cannot assume that learners remember something just because they were in the classroom, shop, or aircraft when the instructor presented the material. Neither can the instructor assume the learners can apply what they know because they can quote the correct answer verbatim. For effective knowledge transfer, learners need to react and respond, perhaps outwardly, perhaps only inwardly, emotionally, or intellectually.

Learning Styles

Learning styles are simply different approaches or ways of learning based on the fact that people absorb and process information in different ways. Learning style is an individual's preference for understanding experiences and changing them into knowledge. It denotes the typical strategy a learner adopts in a learning situation. For example, information may be learned in a variety of ways: by seeing or hearing, by reflecting or acting, analyzing or visualizing, or it may be learned piecemeal or steadily. Just as people learn differently, they also have different teaching methods. Some instructors rely on lectures, others demonstrate, and others may prefer computer simulation training. Everyone has a mixture of strengths and preferences, not a single style or preference to the complete exclusion of any other. Please bear this in mind when using these ideas.

As mentioned in Chapter 2, Human Behavior, and the discussion of personality types and learning, underpinning the idea of learning style is the theory that everyone has an individual style of learning. According to this approach, if the learner and instructor work with that style, rather than against it, both benefit. Currently, 71 different theories of learning styles have been identified. These theories run from simple to complex, usually reflecting scientific research about how the brain processes information. While the scientific community may be surprised at how the research has been used, many educators and school systems have become advocates of applying learning style to teaching methods.

Another model for learning, the Approaches to Learning model, bases its theory on the learner's intentions. For example, is the learner interested in short-term memorization of the material or long-term knowledge? Does the learner want a passing grade on a pop quiz or the ability to use the material to repair an engine? One feature of the Approaches to Learning is that the approach to learning depends on an individual's reasons for learning. This theory reflects the Chapter 2, Human Behavior, discussion of adult learners who come to aviation training with definite reasons.

While controversy exists over the scientific value of learning styles as well as approaches to learning, many educational psychologists advocate their use in the learning process. Knowledge of learning styles and approaches can help an instructor make adjustments in how material is presented if his or her learning/teaching style differs from the way an individual learns. Since a learner's information processing technique, personality, social interaction tendencies, and the instructional methods used are all significant factors, training programs should be sensitive to different learning styles.

Right Brain/Left Brain

According to research on the human brain, people have a preferred side of the brain to use for understanding and storing information. While both sides of the brain are involved in nearly every human activity, it has been shown that those with right-brain dominance are characterized as being spatially oriented, creative, intuitive, and emotional. Those with left-brain dominance are more verbal, analytical, and objective. Generally, the brain functions as a whole. For example, the right hemisphere may recognize a face, while the left associates a name to go with the face.

While most people seem to have a dominant side, it is a preference, not an absolute. On the other hand, when learning is new, difficult, or stressful, the brain seems to go on autopilot to the preferred side. Recognizing a learner's dominant brain hemisphere gives the instructor a guide for ways to teach and reinforce material. There are also some people who use both sides of the brain equally well for understanding and storing information. *[Figure 3-14]*

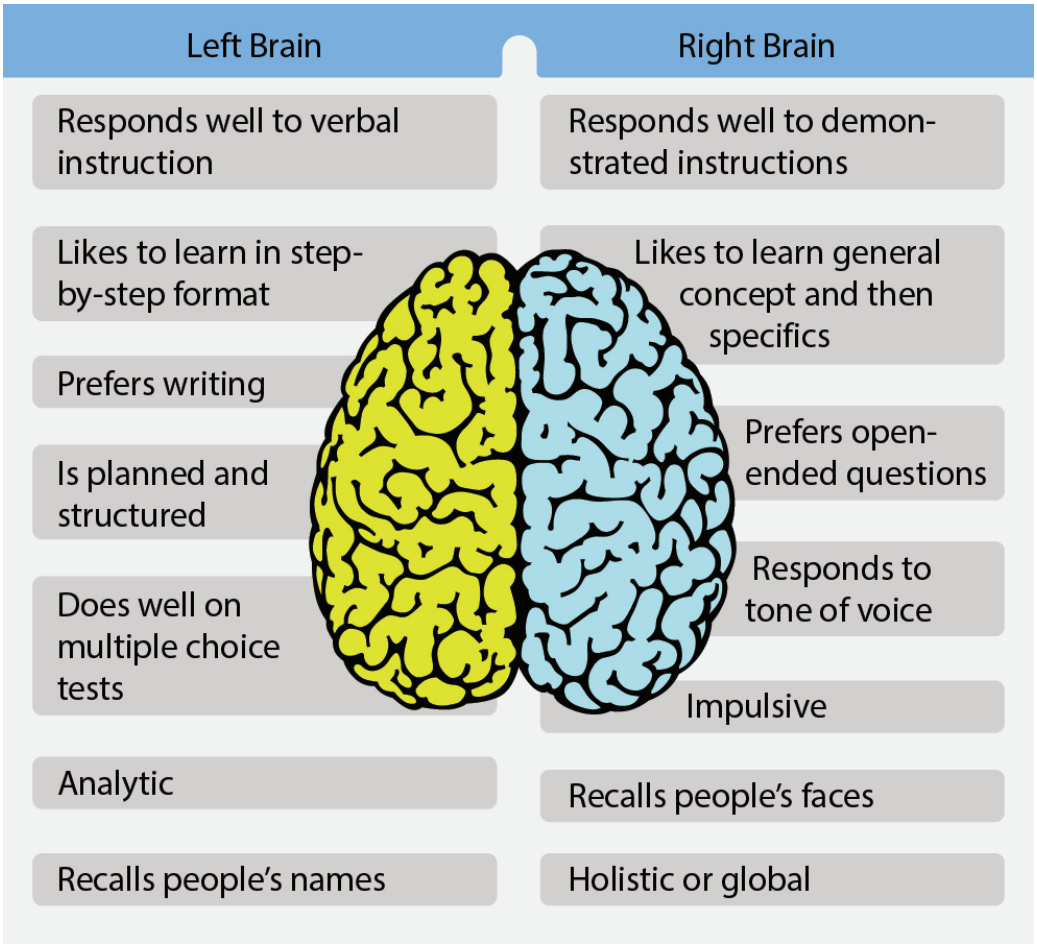

Figure 3-14. *The importance of recognizing a dominant brain hemisphere gives the instructor a guide for ways to teach and reinforce learning.*

Holistic/Serialistic Theory

As seen in *Figure 3-14,* right and left brain learners have preferences for how they process information. Based on information processing theory, left brain learners or serialistic learners have an analytic approach to learning. Because they gain understanding in linear steps, with each step logically following the previous one, these learners need well-defined, sequential steps where the overall picture is developed slowly, thoroughly, and logically. This is a bottom-up strategy.

Right brain or holistic learners favor the holistic strategy and prefer a big picture or global perspective. This is a top-down strategy and learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, until suddenly "it" clicks and they get it. Global learners solve complex problems rapidly once they have grasped the big picture, but they often have difficulty explaining how they did it. This type of learner seeks overall comprehension; analogies help this individual.

Index of Learning Styles

In 1988, Richard Felder and Linda Silverman designed a learning style model with parallel learning styles that classified individuals as having learning preferences in sensing or intuitive, visual or verbal, active or reflective, sequential or global (discussed under holistic/serialistic learning style). A questionnaire developed by Felder and Solomon that offers learners the opportunity to assess learning preferences at no cost for noncommercial purposes is available at www.webtools.ncsu.edu/learningstyles/. *[Figure 3-15]*