Learning Theory: Introduction

A theory is a set of interrelated and interdependent principles that are designed to explain phenomena of interest. Specifically, a theory of human learning would combine principles of human memory, behavior, and learning in order to explain and predict human thought and action. Such a theory of human learning would include three essential components: theoretical principles, theoretical formation, and theoretical function (see Figure 1). The theoretical principles "identify specific factors that consistently influence learning and describe the particular effects of these factors [on thought and behavior]" (Ormrod, 1999, p. 4). These principles are then meaningfully combined or synthesized to form a theory. The theory, however, is useless unless it can be applied through prediction, explanation, or regulation.

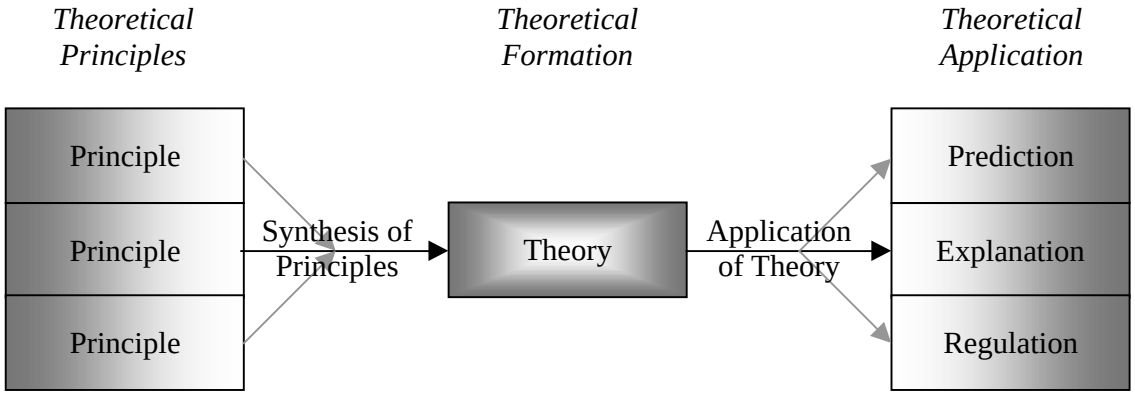


Figure 1. A theory is synthesized from principles of phenomena and seeks to inform the prediction, explanation, and regulation of those phenomena.

While there are several characteristics of valid theories, only three are mentioned here (see Hergenhahn & Olson, 1993). Firstly, the principles and the resultant theory must be verified through observations of the actual phenomena being explained. Good theory is grounded in and agrees with rigorous observation. Secondly, a theory is a synthesis of many, and often disparate, observations. A theory provides an integration of both observational data and the relationships between those data resulting in a clear, though often complex, description. Thirdly, theory is a tool and thus is neither right nor wrong, but rather, useful or not useful. That is, a theory is only as beneficial as its ability to correctly explain, predict, or regulate.

This brief foray into theoretical foundations is necessary to explain the essential role of theory in the formation of guidelines, prescriptions, or suggestions for instruction, learning, and technology. While informal theories of learning have been present for centuries (e.g., Aristotle, “For the things we have to learn before we can do them, we learn by doing them”), more formal theories of learning have only become dominant in the past 100+ years. Learning theory, over the last century, can be subdivided into two essential movements, behaviorism and cognitivism, each with its own proponents (see Figure 2).

Behaviorism		Transition	Cognitivism	
Classical Conditioning	Operant Conditioning	Social Learning Theory	Information Processing	Constructivism
Learning results from the association of one stimulus with another.	Learning results from shaping, via reinforcement and punishment.	Learning results from the observation of others and modeling.	Learning results from the building of mental structures and procedures.	Learning results from knowledge construction based experience.

Figure 2. The field of learning theory may be subdivided into two main fields of thought, each of which has spawned multiple specific learning theories.

In understanding the genesis of behaviorism, one must have a clear sense of the state of psychology at the turn of the 20th Century. In the mid to late 1800s, psychology was dominated by "structuralism." Structuralists, like Wilhelm Wundt (1832-1920), emphasized the discovery of the structure of the mind, built from the basic elements of ideas and sensations. This discovery process was completed through introspection. Introspection was simply the self-examination of one's thoughts, memories, perceptions, and motivations. It was this method of introspection that became problematic. Several psychologists believed that introspection was too subjective and did not serve as a reliable method of investigation.

Partly in protest of structuralism, a new form of psychology evolved, "functionalism." Functionalism, and its proponents such as William James (1842-1910), examined how the processes of the mind, or its functioning, led to adaptive behavior. While the functionalists were concerned with both mental processes and adaptive behavior, the major emphasis was on behavior; that is, what adaptive behaviors resulted from mental processing. One of the major differences between structuralism and functionalism was in the methods used during investigations. While the structuralists used subjective introspection, functionalists used the more objective observation of overt behaviors.

Finally, the trend from the subjective structuralists to the objective functionalists ended in "behaviorism." Behaviorism constituted a refinement of the functionalist perspective. Behaviorists believed in the study of overt behaviors, similar to the functionalists', however, behaviorists went even farther to state that **only** behavior should be studied and not mental events since they were unknowable. Behaviorism was dominated by several scientists, including Edward Thorndike (1874-1949), Ivan Pavlov (1849-1939), John Watson (1878-1958), and B.F. Skinner (1904-1990). In addition, the move from structuralism to functionalism to behaviorism was mirrored by a methodological move from subjective introspection to objective experimentation.

According to John Watson (1925):

> Behaviorism...holds that the subject matter of human psychology *is the behavior of the human being*. Behaviorism claims that consciousness is neither a definite nor a usable concept. The behaviorist, who has been trained always as an experimentalist, holds, further, that belief in the existence of consciousness goes back to the ancient days of superstition and magic. (p. 2)

Learning Theory: Classical Conditioning

Classical conditioning is most associated with Ivan Pavlov (1849-1939), a Nobel Prize (1904) winning Russian physiologist. As learning science lore would have it, Pavlov was working with dogs on a series of digestion experiments when he noticed peculiar patterns to the dog's salivation. The digestion experiments would begin with a research assistant presenting meat or meat powder to the dog, resulting in salivation (which was then collected in vials and measured). Eventually, however, during the experiment the dog began to salivate as the result of the mere presence of the research assistant, in the absence of the any meat or meat powder. This observation led to Pavlov's creation of the classical conditioning model of learning. Pavlov discovered that he could condition the dog to salivate to any of a number of stimuli, such as a bell or tuning fork, by associating the bell or tuning fork stimuli with the meat or meat powder. This discovery was important in that it demonstrated that a simple reflex could be controlled. The generalization was that if a simple reflex or behavior could be controlled, then perhaps a more complex behavior could also be controlled. Also, Pavlov's work revealed the potential benefit of using laboratory experiments in the pursuit of the understanding of learning and behavior.

The essence of Pavlov's classical conditioning is the association of a neutral stimulus with a previously conditioned or naturally conditioned stimulus and response. Specifically, imagine that you are working and your schedule has been very busy. You have missed lunch and are now leaving work at 4:30. As you are leaving the building you smell someone else's dinner as they microwave it. What happens? You begin to salivate and your hunger increases.

The explanation of this smell food and salivate is thus. When we first smell a particular food it is not likely to generate salivation, thus the smell is originally fairly neutral. However, after a few occurrences where we first smell the food, then eat the food, then salivate as a natural response to having food in our mouths, the smelling of the food begins to predict the coming of the food (smell ➔ eat ➔ salivate). It is this predictive value of the smell that leads us to salivate (smell ➔ salivate). All-in-all, we're not so different from dogs!.

It is important to note that not all smells would elicit the salivation response, only those that you associate with food, and those smells that you associate with foods that you like generally will elicit the greatest response. For Pavlov, the important associate to make is between the smelling and eating, since the salivation follows as a natural response.

Now, you may be thinking to yourself, "Yeah, yeah, yeah, just more theoretical nonsense." So here's a few examples of the classical conditioning principle of association.

Why do you like engineering? Law? Architecture? Computer Science?	Engineering ➔ Success ➔ Happiness/Fulfillment
Why do you like Guinness?	Guinness ➔ Social Exchange w/Friends ➔ Happiness
Why do you like your husband's or wife's cologne/perfume?	Cologne/Perfume ➔ Husband's or Wife's Behavior ➔ Feelings of Love

Classical Conditioning Pedagogy

Classical conditioning is often overlooked in education, yet it can explain and provide the rationale for some very powerful behaviors. Teachers are always looking for ways of modifying student behavior and increasing desirable actions, and classical conditioning can help.

1. Students should be active, behavioral participants, in learning situations.

> If an instructor's goal is for students to exhibit certain behaviors (e.g., case analysis) then the teacher should have the students actively involved in those and similar behaviors. Nothing begets behavior, like behavior; to learn to write, one must write.

2. Student practice of learning tasks is essential.

> The strength and usefulness of practice cannot be understated. We will see throughout the various learning theories that practice is paramount in the learning of a behavior. For classical conditioning, practice strengthens the CS-US bond, which is the essence of learning.

3. Teachers should be consistent.

> Consistency is the most important variable in associative learning. The more consistent an instructor is in running his or her classroom and dealing with his or her students, the quicker and the stronger the CS-US association occurs.

4. Teachers should assist students in being successful.

> Success is a powerful US. Instructors should be cognizant of making associations with success. It should be noted, however, that instructors should strive to create challenging and meaningful successes for their students, not easy and meaningless successes.

5. The classroom should be a safe (i.e, non-judgmental, risk-taking) environment.

> A safe environment serves as a large scale US. If the environment is safe, and students feel good about the environment (UR), then those activities (CS) that get associated with the environment are more likely to be liked.

6. Students should practice anxiety-producing situations (e.g., presentations, public speaking).

> When students practice anxiety-producing situations in a safe environment, the students are more likely to begin associating the anxiety-production situations with positive feelings. These positive associations will then facilitate future performance.

7. Instructors need to pay attention to what events are being paired with what learning tasks in their classrooms.

> Students are always making associations — some good, some bad. Often instructors pay little attention to the associations that are being generated in class. Are students making associations between class and failure? Case studies and incompetence? Presentations and praise?

Learning Theory: Operant Conditioning

Common sense. The theory of operant conditioning, as explained by Edward L. Thorndike (1874-1949) and B.F. Skinner (1904-1990), will seem like common sense to most. The basic premise of operant conditioning, or instrumental conditioning as Thorndike called it, is a behavior that is followed by a positive experience is more likely to occur again. For example, a student that attempts to answers a difficult question, and is praised for that behavior, is more likely to attempt to answer difficult questions in the future. Common sense.

Thorndike was really the first person to codify the concepts related to reinforcement-based influences on behavior, although the basic idea has been around as long as parenting. Thorndike called this theory "instrumental conditioning" and its main tenet was the "Law of Effect." The law of effect simply states that reinforcers strengthen the association between a stimulus and a response. Continuing the example of the student that raised her hand, Thorndike would conclude that the reinforcement, the praise, strengthened the association between the teacher asking a question (stimulus) and the student raising her hand (response).

Thorndike, and his instrumental conditioning, was followed by Skinner and his "operant conditioning." In Skinnerian terms, an operant was a behavior that operated on the environment. Thus, operant conditioning was behavioral conditioning. Both instrumental and operant conditioning focus on the role of reinforcement in conditioning behavior. The difference between Thorndike's instrumental conditioning and Skinner's operant conditioning is subtle, but meaningful. Thorndike believed that the stimulus essentially *caused* the animal to respond in a certain way; however, Skinner believed that the stimulus simply provided an environment in which the response may be emitted. Thus, Skinner's operant conditioning focused more on the relationship between the response and the reinforcement, than on the relationship between the stimulus and the response.

The basic operant conditioning model is based on a contingent association between a response (behavior) and reinforcement or punishment. Specifically, the reinforcement leads to the individual emitting that response more often, while the punishment leads to the individual emitting the response less often. Thus, an individual examines the stimuli in his or her environment, responses to some of these stimuli, and the responses are reinforced or punished. The responses that are reinforced are repeated more often, while the responses that are punished are repeated less often. It is important to keep in mind that what is reinforcing or punishing to one individual, may not be reinforcing or punishing to another individual.

Shaping is a very powerful application of the operant conditioning theory. Shaping is used to change the frequency or nature of an individual's behavior when that behavior occurs very infrequently or not at all. Shaping involves the gradual change of a behavior from an initial less desired form to a subsequent more desired form. Shaping can be compared to taking a lump of clay and forming it into a wonderful bowl. As a lump, the clay does not resemble the goal of a bowl; however, over time the lump is gradually shaped into its final form –- a bowl. A behavior is shaped by reinforcing behaviors that more closely approximate the desired behavior, and if need be, punishing behaviors that do not approximate the desired behavior.

Operant Conditioning Pedagogy

1. Use reinforcement to strengthen behaviors you wish to foster.

> The key to using operant conditioning is to focus on reinforcing desired behaviors. Instructors need to be very careful and aware of what is being reinforced. If an instructor allows a student to not turn in an assignment, then the student was just reinforced for not turning in an assignment.

2. Use punishment to weaken behaviors you wish to remove.

> Punishment can be quite effective in eliminating undesired behaviors. Instructors must be careful and aware, however, that their use of punishment is disciplined. While punishment is effective, it should be used sparingly and with discipline.

3. Rely on reinforcing the desired behavior, rather than punishing the undesired behavior.

> While both reinforcement and punishment can both be used to modify behavior, the focus should be on reinforcement. Whenever possible, the instructor should reinforce the desired behavior, rather than punishing the undesired behavior. Stay focused on the positive and use punishment sparingly.

4. Remember, reinforcements and punishments are specific to the individual.

> Using the same reinforcement or punishment for all students is rarely effective. Using reinforcements and punishments effectively requires an instructor to know his or her students.

5. Whenever possible, reinforcers and punishers should be immediate, intense, and *always* contingent on some behavior.

> Contingent. Contingent. Contingent. All reinforcement and punishment must be contingent on a specific behavior for the reinforcement or punishment to be effective. In addition, the student should be well aware of why they are being reinforced or punished.

6. Be willing to reinforce for approximations of the desired behavior, especially when the individual is not likely to produce the desired behavior in its entirety.

> Shaping is the essence of operant conditioning. Teaching complex, unfamiliar, or infrequent behaviors requires patience and the reinforcement of approximate behaviors. Student rarely get it right the first time.

7. Modifying behaviors takes time. Take the time and be patient.

> Changing or modifying established behaviors takes time. Teachers must be patient when attempting to alter a student's habits. These habits were not learned "over-night" and they will not be modified "over-night."

8. Operant conditioning is most appropriate for those that need structure.

> Operant conditioning is an excellent mechanism for providing structure to a student's environment. Thus, those students that lack self-regulation, self-motivation, and self-control tend to benefit more from the structured nature of an operant conditioning environment.

Learning Theory: Social Learning Theory

While behaviorism, classical and operant conditioning, focused on the relationship between an individual's behavior and the environment, as exemplified by research involving animals, social learning theory added an individual's mental processing to the mix and was exemplified by research involving humans. In addition, social learning theory provided the bridge between the behaviorists, which eschewed mental events, and the cognitivists, which embraced mental events.

Social learning theory grew out of early work by Miller and Dollard (1941) and Rotter (1954) which focused on imitation and learning through observation. This early work had a definite behaviorist flavor as Miller and Dollard were students of Clark Hull (1884-1952), a staunch behaviorist. This early work gave way to the social learning movement of the 1960s, led by Albert Bandura, the researcher most associated with social learning theory.

Bandura, born in Canada in 1925, believed that learning was primarily a function of social context. He posited that imitation, observational learning, and modeling were major factors in human learning. In addition, Bandura's social learning theory included a major role for mental events in the generation of behavior. It is this inclusion of mental events (e.g., self-efficacy, self-regulation) that led to the name change from social leaning theory to social cognitive theory. A central concept of Bandura's social cognitive theory is modeling.

Modeling involves both an observer and a model. The observer is changed in some way (i.e., cognitively, behaviorally, affectively) as the result of observing the model. The model could be a live person, a person on the television, a person in a book, an animal, a cartoon, or even written instructions. According to Bandura (1969, 1986), the effective modeling of behavior involves four processes: (a) *attention*, the observer's attention must be focused on the relevant task features of the model's performance, (b) *retention*, the observer must encode the model's performance, verbally and/or visually, in memory, (c) *production*, the observer must be physically able to reproduce the behavior of the model, and (d) *motivation*, the observer must want to perform the modeled behavior. When modeling a behavior, it is imperative that the model draw attention to the critical features of the behavior and provide cues to remembrance.

While modeling occurs in many different domains, for a wide variety of people, models do tend to have similar characters. It should be noted, however, that not all models possess all characteristics. Also, it is imperative to understand that the evaluation of whether or not a model has these characteristics, and to what degree, is dependent upon the observer. Three central characteristics of effective models include: (a) *competence*, the observer believes that the model is competent in the behavior being modeled, (b) *power and prestige*, the observer believes that the model has power and prestige in the domain being modeled, and (c) *relevance*, the behaviors being modeled have some functional value to the observer or the observer's situation.

The ultimate goal of social learning theory is self-regulation. Self-regulation is essentially the intrinsic ability to understand and control one's own behavior through goal setting, monitoring of one's own behavior, reinforcing and punishing oneself, and selecting environments that will facilitate one's appropriate behavior.

Social Learning Pedagogy

Social learning theory provides a perspective on learning that includes the individual, cognitive influences, and the environmental, social influences. A brief summary of social learning includes the following 10 principles (Ormrod, 1999):

1. Observation alone is sufficient for some types of learning.
2. Modeling provides an alternative to shaping for teaching new behaviors, especially for behaviors that the student is not likely to initially emit voluntarily.
3. Instructors and parents are the most influential models in most students' academic lives, thus instructors and parents must be careful to model appropriate behaviors.
4. Instructors should expose students to a variety of exemplary models, including both expert and inexpert models.
5. The four components of modeling (attention, retention, reproduction, & motivation) are essential for successful modeling.
6. Students learn by observing how the instructor treats other students, thus instructors need to monitor the behaviors that are reinforced and punished in the classroom.
7. Describing the consequences of behaviors can effectively increase appropriate behavior and decrease inappropriate behavior.
8. Students must believe that they are capable of accomplishing academic tasks; that is, they must possess high self-efficacy relative to school learning and performance.
9. Students should have help in setting realistic expectations for their own behavior so that they do not suffer unwarranted failure due to inflated/unrealistic goals.
10. Self-regulation techniques can be effective methods of modifying student behavior and should be taught and encourages in all students.

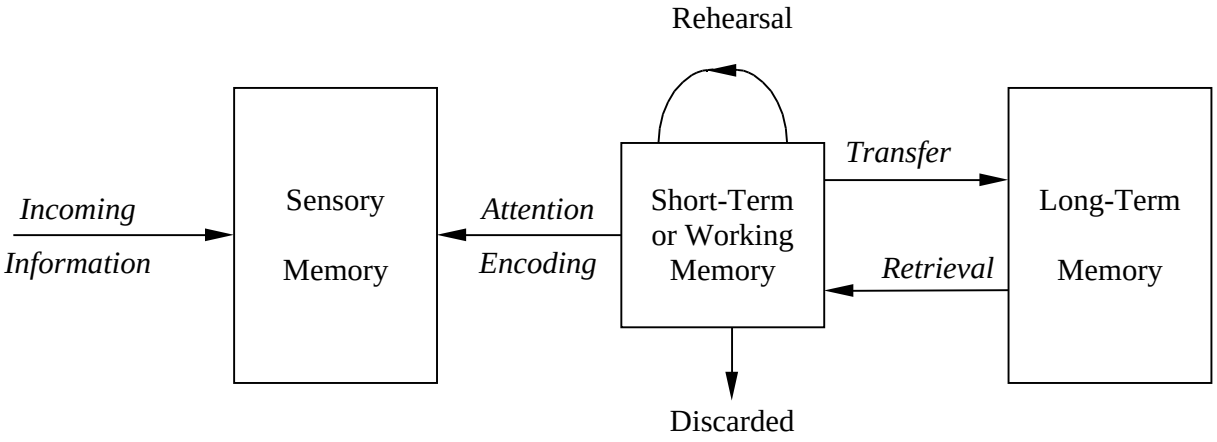
In addition to these 10 summary points, the two main concepts of social learning are modeling and self-efficacy. Modeling, or observational learning, is a powerful process and has been demonstrated to affect many behaviors. Specifically, when students are read to frequently at home, they become better readers themselves; when students are able to watch another person successfully solve math problems, the observing student is more successful; students exhibit less fear in a fear producing situation after observing another student behaving fearlessly in the same situation; students show increased intolerance for racist remarks after observing similar students refusing to tolerate such remarks; and students are more likely to act less gender stereotypically after observing other students acting less gender stereotypically.

Related to self-efficacy, one's belief in one's ability to perform a given task, Bruning et al. (1999) stated, "The most important and consistent finding in the research literature [concerning self-efficacy] is that student self-efficacy is strongly related to critical classroom variables such as task engagement, persistence, strategy use, help seeking, and task performance. High self-efficacy is associated with grater flexibility, resistance to negative feedback, and improved performance (Pajares, 1996)." In addition, these self-efficacy effects are independent of ability; that is, high self-efficacy students out perform low self-efficacy students at all levels of ability and low ability students with high self-efficacy often outperform high ability students with low self-efficacy. Thus, self-efficacy and belief matters!

Learning Theory: Information Processing

Information processing is not a solitary theory with one major theorist as the forefront as with classical conditioning (Pavlov), operant conditioning (Skinner), and social learning (Bruner). Information processing is more of a theoretical perspective; the broad idea that mental events are important and that we can learn much about how and why behavior occurs by studying those events. Information processing theory emerged as a coherent theory in the late 1950s and 1960s as the result of an explosion of mental processing experimentation. This experimentation focused on the components of learning, memory, and cognition. Coinciding with the rise of information processing theory, was the development of the computer. As cognitive science and computer science progressed, information processing theory adopted the metaphor of "mind as computer."

The "mind as computer" metaphor was enhanced by Atkinson and Shiffrin's (1968) dual store information processing model (see below). The dual store model proposed two separate and distinct memory components, short-term memory and long-term memory. Short-term memory was a temporary storage system that was capable of storing only a small amount of information (e.g., a phone number, a few names). As additional information entered the short-term memory, from long-term memory or the sense organs, information currently present in short-term memory had to either be transferred to long-term memory or discarded. Long term memory was a permanent storage system with a virtually unlimited capacity.



Sensory memory, sometimes called the sensory register, stores incoming information that has been obtained by one of the five senses. The "storage" of these senses is quite brief and may involve both the sensory organ and the brain. Since we sense far more from our environment than we can process, we use our attention to focus on those sensations that are important enough to be processed further in working memory.

Working memory is the combination of sensations and prior knowledge, from long-term memory. In addition, working memory provides the memory-based interface between the external world and the internal mind. Just as attention acts as a gateway to working memory, working memory acts as a gateway to long-term memory. Working memory is considered a limited resource structure, that is, working memory can only "hold" approximately 7±2 chunks

of information for only about 20 seconds. Thus working memory has rather severe limitations. These limitations may be overcome in three ways, (a) chunking, grouping information by meaning into discrete units; (b) rehearsal, in order to maintain information in working memory, or to increase the chances of working memory information moving to long-term memory, information must be rehearsed or repeated; and (c) automation, the practicing of tasks and knowledge until the tasks or knowledge may be performed or used with little or no effort. The purpose of working memory is both to allow the individual to interface with the world and to move new experiences into long-term memory.

Long-term memory involves those memories that we remember for days, weeks, years, or a lifetime. How knowledge is stored in long-term memory is not exactly known, thus there are several theories regarding long-term memory storage. Two such theories of long-term memory structure involve episodic and semantic memory, and declarative and procedural knowledge. Semantic memory is knowledge of general concepts, facts, or principles not associated with a particular event. Episodic memory, sometimes called autobiographical memory, is knowledge related to specific, lived, events. A separate, but related theory posits that declarative knowledge is factual or conceptual knowledge. Knowledge that answers the various forms of the question, "What is…"Procedural knowledge is the knowledge of how to do something. Knowledge that answer the various forms of the question, "How do you…" These two sets of memory systems are simply ways of categorizing and thinking about acquired memories.

The basic model of the acquisition of memories begins with experience and is influenced by practice. There is no substitute for experience and practice. One of the strongest research findings in all of information processing experimentation is that practice increases the acquisition of memories. Yes, there are a few situations in which practice may actually inhibit memory acquisition, but these are specialized cases. So, if you want to learn something, practice it. Indeed, continued practice, even after 100% correct rates are achieved, will still result in faster memory record retrieval and faster performance.

In addition to practice, there are three major ways of enhancing the acquisition of memories. Firstly, *depth of processing*, that is, the deeper information is processed, the more effectively that information is acquired and retained. Essentially, depth of processing is the amount of cognitive work that is expended in acquiring a memory and the degree to which that acquisition can be related to prior knowledge. Secondly, *the generate effect*, that is, information that is self-generated improves acquisition and retention of that information. This principle is a form of the depth of processing principle. This creation or generation process requires vast amounts of cognitive effort and thus learning is enhanced. And thirdly, *elaboration*, that is, relating new information to prior knowledge improves memory acquisition and retention. This process of relating new information to old information increases the meaning of the new material and requires a certain depth of processing. Elaboration is essential to memory retention, as it is extremely difficult to remember something that one finds meaningless.

Memory does not do us much good if we cannot retrieve what has been stored. Information may be stored but not retrievable due to the lack of an appropriate retrieval cue. A retrieval cue is a piece of reference knowledge (cue) that is used to activate and subsequently retrieve a known (stored) piece of information. In general, knowledge is more easily retrieved

when the knowledge was well learned initially and if the retrieval cue was present during the initial learning. There has been several interesting investigations conducted concerning the relationship between what occurs during studying and what occurs during testing. The general principle relating studying to test is the *encoding-specificity principle*. Ultimately, study/practice should match test/performance. This matching includes *context*, that is, people retrieve information better when they are asked to recall information in the same environmental setting in which they acquired the information; state or mood, that is, people retrieve information better when they are in the same mental state as when they acquired the information; and *processing*, that is, people retrieve information better when they are asked to process the information the same way both at acquisition and at recall. How one interacts with knowledge and skill during studying or practice will affect how they perform later during a test or competition.

Finally, memory does not store/retain exact replicas of information, thus at retrieval, the mind rebuilds a complete memory, often filling in unknown details through inference. Have you ever read a story to a child and then asked the child to retell the story back to you? If you do you will notice that certain details are left out of the child's story and then certain details that were not in the original story suddenly appear! The child is not lying, nor is the child trying to expand the story. As the child retells the story the child's mind simply fills in gaps with information that makes sense. Thus "Jack and Jill went up the hill to fetch a pail of water" becomes "Jack and Jill ran up a hill to get water from a well with a pail." The general idea is the same, but the child has added some details, details that make sense to the child given the general idea of the story. It should be noted, however, that this concept does not only apply to children, adults add and subtract information when reconstructing ideas and concepts also. The main point of reconstructive memory is that we do not remember exact replicas of experience, but rather we tend to remember the general idea of what occurred or what was said and then fill in details as needed.

The preceding findings may be condensed into the following six statements.

1. Learning is an active process of building organized mental structures.
2. Learning is a process that relates new information to previously learned information.
3. Learning is a function of the quality, as well as the quantity, of processing.
4. Learning is influenced by the context in which it occurs.
5. Learning is enhanced through self-monitoring of learning processes and capabilities.
6. Learning is reconstructive.

Information Processing Pedagogy

These six, empirically based statements may then be transformed into pedagogical statements,

1. Classroom activities should be created that use environmental cues to facilitate learning.

   A large portion of learning is contextually linked. Students need to be aware of the conditions under which their knowledge and skills are relevant. Instructors should be explicit in making these links between knowledge and skill usefulness and context.

2. Classroom activities should be created that foster the building of mental structures.

   Instructors should focus on building understanding, not disseminating it. Students build up mental structures of knowledge through the use of examples, applied problems, and reading. Processes that build knowledge should focus on moving from the concrete to the abstract and the less complex to the more complex.

3. Students should be encouraged to actively process information and experiences.

   The key to moving information from working memory to long term memory is cognitive processing. Cognitive processing involves students relating new knowledge to prior knowledge, creating knowledge artifacts such as drawings or essays, and reflecting on their declarative and procedural knowledge. A key question to ask is, "What are my students doing, cognitive, during this activity or lecture?"

4. Students should be encouraged to reflect on and elaborate their experiences and understandings.

   Two essential forms of cognitive processing include elaboration and reflection. Elaboration involves the active relating of new knowledge and experience to prior knowledge. Further, elaboration involves the student embellishing new knowledge and experience with prior knowledge. Elaboration is the primary method of creating long-term memories. In reflection, students are asked to examine their own thought processes and knowledge. This reflection builds interrelationships among prior knowledge.

5. Teachers should provide for unique, idiosyncratic interpretations of experience.

   Students will build knowledge structures and process based on their own past experiences. As student past experiences vary, so will their construction of new knowledge. Instructors should not only expect students to build idiosyncratic understandings of material, they should anticipate it and tap into it by asking students to explain their understandings and by providing flexible assignments and activities that allow students some flexibility in how the assignments and activities are completed.

6. Teachers should create activities that relate to the student's current level of understanding, knowledge, and experience.

   In order to relate new knowledge and experiences to prior knowledge, the new knowledge and experiences must be at a level that is close to the student's prior knowledge. If the instructor begins a lesson "above the student's head", the student rarely catches back up. Further, if the instructor uses examples and methods with which the student is familiar, the student will be more highly motivated to engage in the material and will make more new knowledge to prior knowledge connections.

Learning Theory: Constructivism

Education has long been driven by its metaphors for teaching and learning. These metaphors have influenced both educational research and educational practice (Leary, 1990). Since the late 1800s, three metaphors have dominated education: learning as the acquisition of stimulus-response pairs (behaviorism), learning as the processing of information (information processing), and learning as the construction of knowledge (constructivism) (Mayer, 1992). Constructivism emerged from information processing as a way of emphasizing socialization processes and a postmodern view of truth and knowledge.

Constructivism, succinctly defined, is the belief that learners construct their own knowledge from their experiences. A more eloquent and inclusive definition is provided by Fosnot (1996),

> Learning from this perspective is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insights, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate. (p. ix)

Therefore, constructivism involves the active creation and modification of thoughts, ideas, and understandings as the result of experiences that occur within a socio-cultural context. It is this combination of learner autonomy and holistic perspective that has thrust constructivism to the forefront of learning science and education. Learner autonomy is the concept that learners are active participants in the learning process and ultimately responsible for their own learning. The holistic perspective is a non-reductionist approach that emphasizes learning in context.

The integration of learner autonomy and a holistic perspective places constructivism at the nexus of philosophy, psychology, and pedagogy. A foundational is the role of epistemology; that is, what is the nature of knowledge and how does the knower come to know. From this epistemological perch, the pillars of constructivism have emerged as:

- Knowledge is not passively accumulated, but rather, is the result of active cognizing by the individual;
- Cognition is an adaptive process that functions to make an individual's cognition and behavior more viable given a particular environment or goal;
- Cognition organizes and makes sense of one's experience, and is not a process to render an accurate representation of reality; and
- Knowing has its roots in both biological/neurological construction and in social, cultural, and language-based interactions (Garrison, 1998; Gergen, 1995; von Glasersfeld, 1984).

Thus, constructivism emphasizes the active role played by the individual learner in the construction of knowledge, the primacy of social and individual experience in the process of learning, and the realization that the knowledge attained by the learner may vary in its accuracy as a representation of reality. The adoption of these assumptions changes the nature of education from one of a search for truth, to one of a search for perspective.

Constructivist Pedagogy

1. Learning should take place in authentic and real-world environments.

Whether building accurate representations of reality, consensual meanings in social activities, or personally coherent models of reality, experience is paramount. Experience, both socially oriented and object oriented, is a primary catalyst of knowledge construction. Experience provides the activity upon which the mind operates. In addition, knowledge construction is enhanced when the experience is authentic.

2. Learning should involve social negotiation and mediation.

Social interaction provides for the development of socially relevant skills and knowledge, as well as providing a mechanism for perturbations that may require individual adaptation. In some cases, such as cultural mores and culturally arbitrary rituals (e.g., greetings, gender relations, dress), knowledge can only be attained through social contact. Finally, an integral component of social mediation is the use of language. Language is the medium through which knowledge and understanding are constructed.

3. Content and skills should be made relevant to the learner.

If knowledge is to enhance one's adaptation and functioning, then the knowledge attained must be relevant to the individual's current situation, understanding, and goal. Ultimately, experience with relevant tasks will provide the individual with the mental processes, social information, and personal experiences necessary for enhanced functioning within one's practical environment.

4. Content/skills should be understood within the framework of the learner’s prior knowledge.

All learning begins within an individual's prior knowledge. Understanding a student's behavior requires an understanding of the student's mental structures, that is, an understanding of the student's understanding. Only by attempting to understand a student's prior knowledge will the teacher be able to create effective experiences, resulting in maximal learning.

5. Students should be encouraged to become self-regulatory, self-mediated, and self-aware.

The underlying tenet of constructivism is the claim that learners are active in their construction of knowledge and meaning. This activity involves mental manipulation and self-organization of experience, and requires that students regulate their own cognitive functions, mediate new meanings from existing knowledge, and form an awareness of current knowledge structures.

6. Teachers serve primarily as guides and facilitators of learning, not instructors.

This teacher as guide metaphor indicates that the teacher is to motivate, provide examples, discuss, facilitate, support, and challenge, but not to attempt to act as a knowledge conduit.

7. Teachers should provide and encourage multiple perspectives and representations of content.

Experiencing multiple perspectives of a particular event provides the student with the raw materials necessary to develop multiple representations. These multiple representations provide students with various routes from which to retrieve knowledge and the ability to develop more complex schemas relevant to the experience. In addition, in constructivism there is no privileged "truth," only perceptual understandings that may prove to be more or less viable. This being the case, a student's understanding and adaptability is increased when he or she is able to examine an experience from multiple perspectives.

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