Adult Learning and the Evolution of Learning Theories:

Grounding your Educational Philosophy

Workshop Materials

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Activities

Activity I:
What's Your Theory (Educational Philosophy)?

1. **Do you think reality is objective or subjective? What are your epistemological beliefs?**

2. **How and why do you think people learn?**

3. **What should/do you do to facilitate learning?**

Activity II:
Discuss Adult Learning

A. Key Concepts and Principles

B. Questions

Activity III:
Discuss Experiential Learning

A. Key Concepts and Principles

B. Questions

Activities IV
Review [Principles] & Revise [Philosophy]

A. Key Concepts and Principles

B. Questions

4. **How and why do you think people learn?**

5. **What should/do you do to facilitate learning?**

Activity V:
Reflections

1. What were the (3-5) most interesting things you learned during the workshop?

2. How will you apply what you learned from the workshop?

3. What did you like about the workshop and why?

4. What would you change, and how?

Handouts

Brief Summary of Learning Theories & Epistemological Beliefs

Over the past century, educational psychologists and researchers have posited many theories to explain how individuals acquire, organize and deploy skills and knowledge. To help readers organize and apply this extensive body of information, various authors have also classified these theories in different ways (e.g., Driscoll, 1994; Bruning, Schraw & Ronning, 1995). Here, learning theories are grouped into four basic classes: (a) behaviorist learning theories; (b) cognitive-information processing learning theories; (c) cognitive-constructivist learning theories; and (d) neurobiological.

Figure 1 illustrates how four major classes of learning theories have evolved overtime. References to related authors are by no means exhaustive; rather, it reflects a small sample for illustrative purposes. It is assumed that readers have had some previous exposure to most, if not all of theories included here—perhaps in a graduate or an undergraduate educational psychology course. Thus, only a brief overview of extensive literature is provided to stimulate the recall of prior knowledge and to help readers make informed decisions about their own personal educational philosophy. For further detail, readers are encouraged to read the references provided within the text.

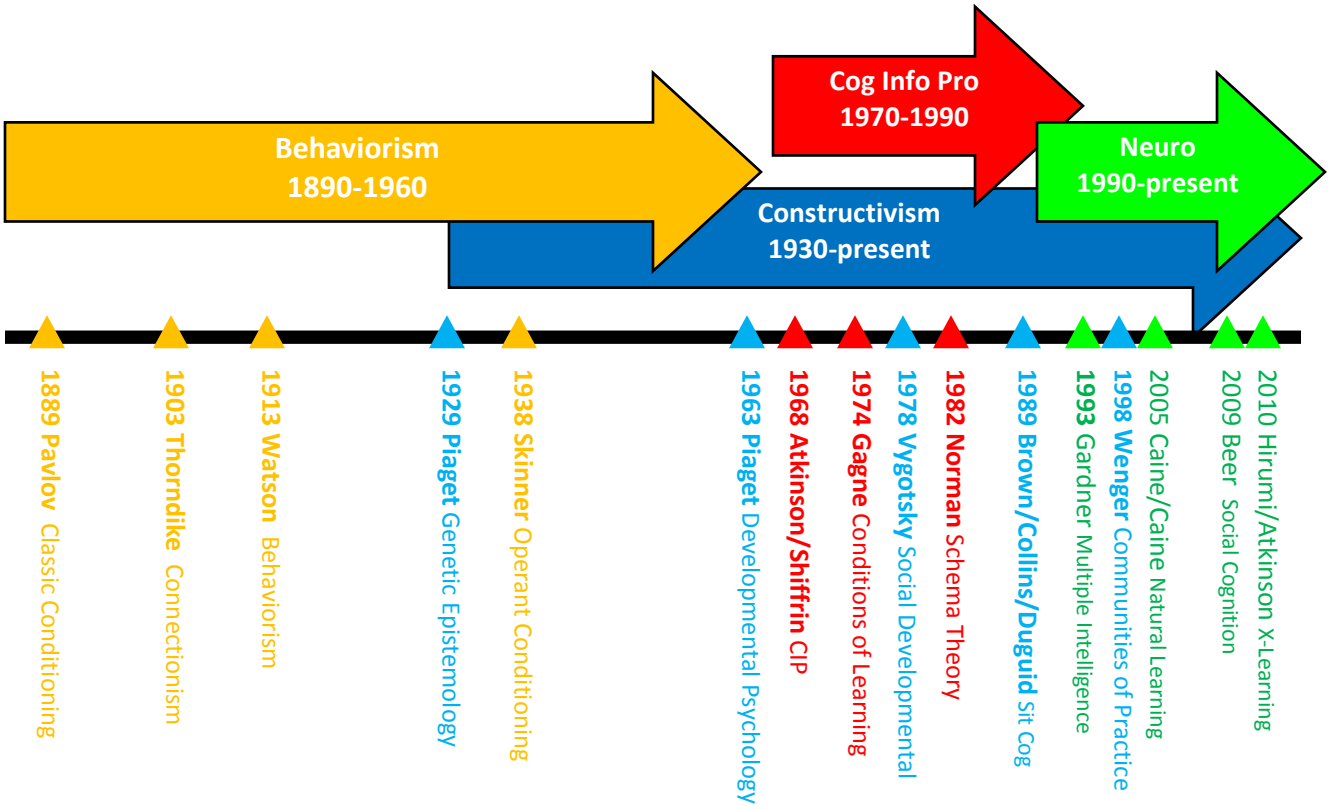

Figure 1. Evolution of basic categories of learning theories

Behaviorist Learning Theories

The origins of behaviorist learning theories may be traced backed to the late 1800's and early 1900's with the formulation of "associationistic" principles of learning (c.f., Dellarosa, 1988). The general goal was to derive elementary laws of learning and behavior that may then be extended to explain more complex situations. Inferences were tied closely to observed behavior in "lower organisms" with the belief that the laws of learning were universal and that work with laboratory animals could be extrapolated to humans. It was believed that a fundamental set of principles derived from the study of learning in a basic or "pure" form could then be applied to the broader context of learning in schools. From 1920 to 1970, associationism was thought to be the American psychology because there were no real alternatives in the United States at that time (Glover & Ronning, 1987).

Three experimental approaches are related to the study of associationistic learning including: (1) the use of nonsense syllables and individual words to study the association of ideas; (2) the use of animals to study the association between sensations and impulses; (3) the use of animals to study association and reflexology.

The Association of Ideas. Following a tradition begun by Ebbinghaus (1885), researchers studied learning in terms of memory for individual items, most commonly nonsense syllables and individual words. It was assumed that understanding simpler forms of learning would lead to understanding of more complex phenomena. During this time, the predominate research methods were those of serial list learning and paired associate learning. These methods allowed researchers to study, predict, calculate and calibrate "associations" or the degree/likelihood that a nonsense syllable or word could elicit a particular response from learners. In short, the basic premise underlying associationistic views of learning was that ideas become connected, or associated, through experience. Furthermore, the more frequently a particular association is encountered, the stronger the associative bond is assumed to be. For example, the stimulus "bread" is likely to elicit the response "butter" more often and more rapidly than the response "milk," because the association between bread and butter has been frequently experienced and thus has become well learned.

The Association between Sensations and Impulses. Like Ebbinghaus, Thorndike was also interested in studying learning in terms of associations, but in terms of actions, rather than ideas. For his research, Thorndike used animals (e.g., cats and chickens) which were placed in "puzzle boxes" and measured learning in terms of the amount of time it took for the animal to operate a latch and escape. The results led Thorndike to believe that animals learned to associate a sensation with an impulse when its action had a satisfying consequence. For instance, an animal may form an association between a sense (the interior of a box) and an impulse (operating a latch) because the action led to a satisfying result--namely, escaping the box. This principle, termed the Law of Effect, helped modify the classical principle of

association and later held significant implications for behaviorism. One of the clearest formulation of associationistic learning principles were made by Hull (1934, 1952) and Spence (1936-1956). Like Thorndike, Hull and Spence based their propositions on data from numerous experiments with laboratory animals. However, unlike Thorndike, Hull and Spence derived equations to explain different actions such as habits, drive and inhibitions. Hull (1952) was able to demonstrate that the elementary laws of learning captured in these equations could account for a number of behaviors such as trial-and-error learning and simple discrimination learning in animals.

Associationism and Reflexology. A third approach to the study of associations, led by Pavlov, brought together the principles of associationism and reflexology. Pavlov noticed that dogs salivated not only to food, but often to a variety of other stimuli, such as the sight of a trainer who brought the food. He called this response a learned reflex that is established through the association between an appropriate stimulus (food) and an inappropriate one (the trainer). In other words, a relatively neutral stimulus is associated with something that causes a response until the neutral stimulus also causes the response. This lead to an extended research program now known as classical conditioning. According to the principle of classical conditioning, a unconditioned stimulus (UCS) biologically and involuntarily elicits an unconditioned response (UCR). For example, the site of food (UCS) elicits salivation (UCR). Then, as a conditioned stimulus (trainer) becomes associated with the unconditioned stimulus (food), it (the trainer) acquires the ability to elicit the same response (salivation). Because the response is now conditioned to a new stimulus, it becomes a conditioned response (Figure 2).

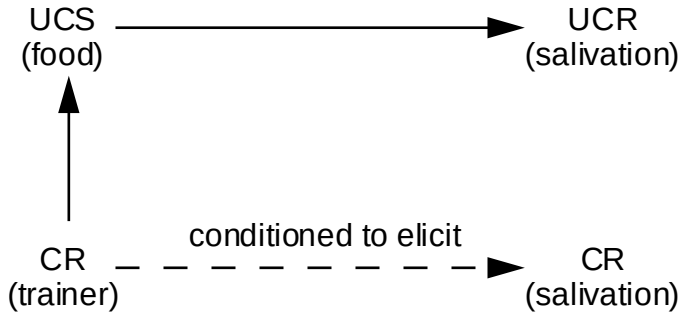

Figure 2. Illustration of Classical Conditioning

A significant problem became apparent as associationistic research continued, As experimental psychologists made finer and finer distinctions to their research on “trial and error” learning in animals and their studies of rote memory, their results appeared to be less and less relevant for education. The search for general laws that crossed all species and settings was failing. As methods were refined and experiments became more valid internally, they were becoming less valid externally (Campbell & Stanley, 1963). The “laws of learning” in the United States were becoming known as the “laws of animal learning,” “the laws of animals learning to make choices in mazes,” or the “laws of human rote memory” rather than the universal principles sought after by early Associationists.

However, not all associationist psychologies resulted in theoretical or applied dead-ends. The so-called radical behaviorists, led by Skinner (1938, 1953), have had a strong impact on both psychology and education. Like early works by Watson (1924), Skinner rejected the idea that the purpose of psychology was to study consciousness, rather the goal was to predict and control observable behavior. Learners were seen as coming to learning situations *tabula rasa*, subject to conditioning by their environment. It was believed that by controlling the environmental antecedents and consequences for behavior, people could prediction and control that behavior. In addition, by providing positive consequences for behavior and by controlling the schedule by which these consequences were delivered, behavior could be further controlled and shaped. In his research, Skinner demonstrated that laboratory animals were sensitive to manipulation of both antecedents and consequences of their actions and that simple responses, such as bar pressing and pecking, could be predicted with high confidence. Based on these observations, Skinner proposed a basic stimulus-response-stimulus (S-R-S) relationship as depicted below (Figure 3).

S	---------->	R	---------->	S
discriminative stimulus		operant response		contingent stimulus

Figure 3. Basic S-R-S Relationship

In brief, the nature of the contingent stimulus is believed to determine what happens to the response, whether it is reinforced or lost. In other words, behavior is more likely to reoccur if it has been rewarded or reinforced. Similarly, a response is less likely to occur again if its consequences have been aversive. These principles are referred to as the contingencies of reinforcement which suggest that to understand learning, one must look for the change in behavior that occurred and determine what consequences were responsible for the change (Skinner, 1969). The basic S-R-S relationship provides the framework from which most behavioral learning principles and their applications for instruction and education are derived. Behavioral learning theories have contributed to instruction and education in several significant ways. The three applications summarized here include: (a) Behavior Modification; (b) Classroom Management; and the Management of Instruction.

Behavioral Modification. Also known as behavior therapy or contingency management, behavior modification is typically used to treat behavior problems in social, personal, or school situations. Some clinical applications include treatments for phobias, obsessions or eating disorders (Bower & Hilgard, 1981). Educational applications involve the treatment of school-related problems such as the lack of attention, hyperactivity, temper tantrums, or other behaviors that interfere with the regular workings of a classroom. Special education teachers are typically well trained in behavioral modification. In each of these instances, the S-R-S model and it's resulting principles are used to shape, modify and otherwise control behavior.

Classroom Management. While behavioral therapists and special education teachers apply behavioral learning principles to address individuals, teachers in regular classrooms may use the same principles to help manage the behavior of twenty to thirty children. For instance, teachers may set up group contingencies (a standard reinforcement given to a group) for following certain rules of conduct. A kindergarten teacher, for example, may take his/her students out to the playground 10-15 minutes early if they all pick up their things. One common means of applying group contingencies that some teachers find useful is the token economy (Ayllon & Azrin, 1968). In this system, tokens serve as conditioned reinforcers that can later be exchanged for objects or privileges. Tokens are earned for good conduct--whatever behaviors have been selected by the teacher for strengthening. Since tokens operate like money, students may also be fined for breaking the rules or engaging in undesirable behavior.

Management of Instruction. Behavioral principles have proved useful, not only for managing student behavior, but also for managing the way instruction is delivered. The most prominent examples of how behavioral learning theories have been applied to the management of instruction include the development of: (1) behavioral objectives, (2) contingency contracts, and (3) personalized system of instruction (PSI). Behaviorists, as well as others, argue that the only evidence of learning comes from the study of overt behaviors. How can one be sure that a student acquired knowledge or a skill unless we can see them actually do something with that knowledge or skill? Thus, to assess the degree to which a student achieved an objective, it is important to specify desired instructional outcomes in terms of clear, observable behaviors (aka. behavioral, instructional, learning, or performance objectives). An instructional application that often makes use of both behavioral modification and instructional objectives is the contingency contract. Used with individual students, the contract sets out the terminal behavior the student is to achieve, along with the conditions for achievement and the consequences for completion (or non-completion) of assigned tasks. Keller (1968) proposed a whole new approach to college instruction based on behavioral principles known as the personalized system of instruction (PSI). PSI calls for course materials to be broken up into units, each with a set of behavioral objectives. Students tackle course materials on their own, often aided by study guides which provide practice on unit objectives. To proceed, students are required to demonstrate mastery by taking a unit quiz. Students receive feedback immediately and if they pass, they can go on to the next unit. If they fail, they must remediate and take the quiz again, but with no penalty.

Cognitive-Information Processing Learning Theories

No single point in time signaled the end to the associationistic or behavioral era, and the beginning of the cognitive revolution. Early on, the cognitive revolution was a quiet one. However, as American psychologists became increasingly frustrated with the limitations of behavioral theory and methods, and persuasive arguments against radical behaviorist theories were being put forth by linguists studying language development, the "time as right" for the emergence of cognitivism. Another prominent factor was the development of computers (Baars, 1986), which provided both a credible metaphor for human information processing, and a significant tool for modeling and exploring human cognitive processes.

One major group of cognitive theories may be classified as cognitive-information processing learning theories. According to the cognitive information processing (CIP) view, the human learner is conceived to be a processor of information, in much the same way a computer is. When learning occurs, information is input from the environment, processed and stored in memory, and output in the form of a learned capability. Proponents of the CIP model, like behaviorists, seek to explain how the environment modifies human behavior. However, unlike behaviorists, they assume an intervening variable between the environment and behavior. That variable is the information processing system of the learner.

Most models of information processing can be traced to Atkinson and Shiffrin (1968) who proposed a multistage theory of memory in which information received by the processing system undergoes a series of transformations before it can be permanently stored in memory. Displayed in the figure are three basic components of memory (i.e., sensory memory, short-term memory, and long-term memory) along with the processes assumed to be responsible for transferring information from one stage to the next. This system provides the basic framework for all learning theories classified under the cognitive-information processing category. The following is a brief summary of each major component of the information-processing system and their implications for instruction. Figure 4, adapted from Driscoll (1994) depicted the primary stages associated with CIP theories of human learning.

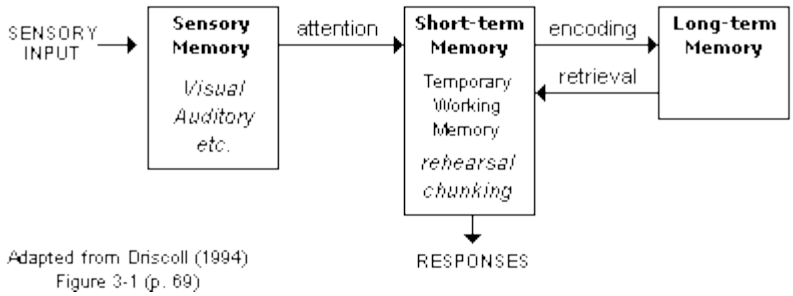

Figure 4. Basic cognitive information process model of human learning

Sensory Memory. Sensory memory represents the first stage of information processing. Associated with the senses (vision, hearing, etc.), it functions to hold information in memory very briefly, just long enough for the information it to further processed. It is believed that there is a separate sensory memory corresponding to each of the five senses, but all are assumed to operate in the same way.

Selection Attention. Selective attention refers to the learners' ability to select and process certain information while simultaneously ignoring other information. The degree to which an individual can spread their attention across two or more tasks (or sources of information) or focus on selected information within a single task depends on four factors: (1) the meaning of the task or information to the individual; (2) the similarity between competing tasks or sources of information; (3) task complexity or difficulty; and (4) the individuals ability to control attention.

Pattern Recognition. Just attending to information is not enough to ensure its further processing. Attention is believed to be necessary but not sufficient; information must be analyzed and familiar patterns must be identified to provide a basis for further processing. Pattern recognition refers to the process whereby environmental stimuli are recognized as exemplars of concepts and principles already in sensory memory.

Short-Term Memory. Short-Term Memory (STM) functions as a temporary working memory where further processing is carried out to make information ready for long term storage or a response. At this stage, concepts from long-term memory (LTM) are also activated for making sense of the incoming information. STM or working memory has been likened to consciousness. When we actively think about ideas and are therefore conscious of them, they are said to be in working memory. STM, however, only holds a certain amount of information for a limited amount of time.

Rehearsal & Chunking. Rehearsal and chunking are two processes that may help individuals encode information into long-term memory. When you repeat of phone number to yourself over and over again, you are engaged in rehearsal. Chunking is the grouping of ideas, letters, phrases, etc. into bits of information to facilitate the encoding process. Take for example, the following span of letters: JFKFBIAIDSNASAMIT. As individual letters, they more than exceed the capacity of working memory. However, as five chunks--JFK, FBI, AIDS, NASA, and MIT--they are easily processed.

Encoding. Encoding refers to the process of relating incoming information to concepts and ideas already in long-term memory in such a way that the new material is more memorable. Encoding serves to move information from STM to LTM. In short, it is believed that individuals impose their own subjective organization to materials to learn them. However, techniques such as outlining, hierarchies, concept trees, mnemonics, mediation and imagery have all been shown to aid the encoding process.

Long-Term Memory. Long-term memory (LTM) represents our permanent storehouse of information. Anything that is to be remembered for a long time, must be transferred from STM to LTM. Although forgetting is a phenomenon we have all experienced, it is assumed that once information has been process into LTM, it is never truly lost. As far as we know, LTM is capable of retaining an unlimited amount and variety of information. It is limitations in our retrieval process, that is believed to constrain our ability to remember. There are a number of different views of how information is stored in LTM including, but not limited to schemas and mental models.

Retrieval. The process of retrieval from long-term memory is relatively simple to understand. Previously learned information is brought back to mind, either for the purposes of understanding some new input or for making a response. Using previous knowledge to understand and learn new material has already been discussed as encoding. Using previous knowledge to make a response is known as retrieval.

There are a number of alternative cognitive learning theories and concepts, including, but are not limited to: Levels or Depth of Processing, Meaningful Learning, Schema Theory, and Mental Models. These all relate learning with information processing, which is why they are grouped here, but do not necessary adhere to the CIP model.

Cognitive-Constructivist Learning Theories

Since space limitations prevent an extensive discussion of constructivism, in addition to those cited in the following paragraphs, interested readers are referred to the works of von Glasersfeld (1989, 1981), Jonassen (1991), Marra and Jonassen (1993) and Rorty (1991). In brief, there is no single constructivist theory. Constructivist approaches to teaching and learning is grounded in several research traditions (Perkins, 1991; Paris & Byrnes, 1989).

The roots of constructivism may be traced back to a little known Latin treatise, *De antiquissima Italorum sapientia* , written in 1710 by Giambattista Vico (as cited in von Glasersfeld, 1991). Vico suggested that knowledge is knowing what parts something is made of, as well as knowing how they are related. “Objective, ontological reality, therefore, may be known to God, who constructed it, but not to a human being who has access only to subjective experience” (p. 31, von Glasersfeld, 1991).

A second, related path to constructivism comes from Gesalt theories of perception (Kohler, 1924) that focus on the ideas of closure, organization and continuity (Bower & Hilgard, 1981). Like Vico, Gesalt psychologists suggest that people do not interpret pieces of information separately and that cognition imposes organization on the world.

Theories of intellectual development provide a third research tradition contributing to the notion of cognitive construction (e.g. Piaget, 1952, 1969, 1971; Baldwin, 1902, 1906-1911; Bruner, 1974). Developmentalists believe that learning results from adaptations to the environment that are characterized by increasingly sophisticated methods of representing and

organizing information. Developmental scientists also forward the notion that children progress through different levels or stages which allow children to construct novel representations and rules (Carey, 1985; Case, 1985; Sternberg, 1984; Keil, 1984; Siegler, 1983).

A fourth line of research depicts learning as a socially mediated experience where individuals construct knowledge based on interactions with their social and cultural environment. Like Piaget and Bruner, Vygotsky (1962, 1978) believed that the formation of intellect could be understood by studying the developmental process. However, like Bruner, Vygotsky felt that intellectual development could only be fully understand within the sociocultural context in which the development was occurring.

These four sources provide the foundations for constructivism applied to education. The common belief that knowledge is constructed within a social context is the foundation for this group of learning theories. No discussion of learning theories, however, is complete without examining their epistomological assumptions.

Neurobiological Learning Theories

Advances in neuroimaging technology and neuroscience research continue to revolutionize our understanding of the human brain functions and how we treat both physical and mental traumas and disorders. Functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and functional infrared spectroscopy (fNIRs), electroencephalography (EEG), magnetoencephalography (MEG), and other related techniques, can now measure blood flow, oxygenation levels, and electrical signals in tens of thousands of neurons in the brain. Clinical and experimental neuroscientists now utilize an array of such neuroimaging technologies to study and diagnose neurological disorders, leading to many new insights into how we treat physical and mental ailments such as Alzheimer’s and Parkinson’s Disease, Cerebral Palsy, Epilepsy, Schizophrenia, Spinal Paralysis and Heart Stroke. It is believed that a better understand of that anatomy, physiology, and neural mechanisms that govern human learning will also lead to valuable insights on how to develop and measure effective training and educational interventions.

Neurobiological learning theories represent a physiological approach to correlating learning to electrical and chemical activities taking place in the brain and central nervous system. Neuroscientists use imaging technology to gain a better understanding of how the brain functions from an anatomical and physiological perspective. In contrast, behavioral and cognitive psychologists, typically use observations, paper and pencil tests, and anecdotal self-reports to advance psychological explanations of how the mind works. Much of what has been discovered from cognitive and educational neuroscience is proving to be extremely useful in explaining how and why people learn, and improving the effectiveness and efficiency of training and educational programs. Increased knowledge about how the eyes, ears and other sensory organs work and pass information to the brain, for example, has led to a greater understanding of how to attract and maintain a learner's attention. Similarly, increased knowledge about how sensory information is actually processed in the brain is leading to a greater understanding of such things as the nature of memory.

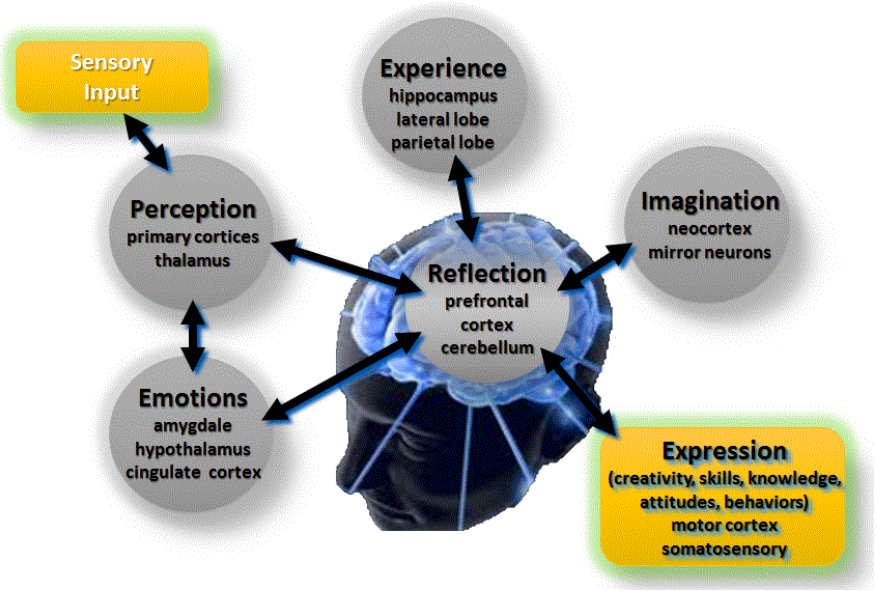

Figure 4. Dimensions of Experiential Learning

Figure 4 depicts five major branches of neuroscience research related to learning that form what we posit as five dimensions of experiential learning (Hirumi, 2013; Hirumi & Aktinson, 2011). In short, we believe neuro networks associated with human perception, emotions, experience, imagination and reflection directly affect how we express creativity, skills, knowledge, attitudes and behavior.

We recognize that others who read the same or alternative cognitive, educational and other types of neuroscience research and literature may come up with a different dimensions that affect learning. We also recognize that many may still question the generalizability and value of synthesizing the results of cognitive neuroscience research into an instructional prescriptions and theory. At present, such propositions are still in their infancy. However, ultimately, it may be possible to explain complex human behaviors in terms of such neurobiological activities. In the meantime, the neurobiological approach is proving extremely useful in providing basic data for the fourth major class of learning theories.

A Brief Summary of Epistomological Beliefs

Over the past century, social psychologists have taken a number of alternative approaches to explain how the mind acquires knowledge. One extreme is characterized by an objectivist epistomology that suggests that reality is external to individuals and is based on natural laws, physical properties and their relationships. Objectivists believe that the mind processes symbols and mirrors reality, and that thought is governed by, and reflects external reality. Objectivists believe that meaning is external to and independent of the understanding of individuals.

The polar opposite of objectivism is interpretivism. Interpretists believe that knowledge is constructed. The mind interprets sensory data and organizes it through active and dynamic processes according to innate perceptual categories such as numerosity and animacy (Keil, 1982; Herrnstein & Boring, 1968; Bower & Hilgard, 1981). Furthermore, interpretists emphasize concepts, such as perceptual relations (Gibson, 1966) and the structure of language (Chomsky, 1965) that are imposed upon the world by individuals. Interpretists believe that reality is internal to the organism and that meaning is dependent on individual understanding.

An alternative to both objectivism and interpretivism is pragmatism (Driscoll, 1994). Pragmatists also believe that reality is "constructed." However, the meaning derived by individuals is believed to be negotiated within a social context. Unlike interpretists, pragmatists believe that individuals' reality is mediated by their prior knowledge structures and their interactions with the environment and with others. They believe that the mind builds symbols and interprets nature, and that thought is governed by individuals' perceptions that reflect their internal reality. Pragmatists believe that meaning is constructed by individuals based on their interpretation and understanding of reality.

A comparison of objectivist versus constructivist/interpretist epistomologies is provided in the lecture notes. A further comparison of objectivism, pragmatism and interpretivism (Driscoll, 1994) is given here (Table 1).

Table 1. A Comparison of Three Epistomological Perspectives

	Objectivism	**Pragmatism**	**Interpretivism**
Assumptions about reality	Reality is objective, singular, fragmentable	Reality is interpreted, negotiated, consensual	Reality is constructed, multiple, holistic
Nature of truth statements	Generalizations, laws, focus on similarities	Working hypotheses, focus on similarities and differences	Working hypotheses, focus on differences
Sources of knowledge	Experience	Experience and reason	Reason
Types of research designs	Experimental, a priori	any design may be useful for illuminating different aspects of reality	Naturalistic, emergent
Associated learning and instructional theories	Behaviorism, Cognitive information processing, Gagne instructional theory	Educational semiotics, Bruner's and Vygotsky's views of learning and development	Piaget's developmental theory, radical constructivism

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Learning and Instructional Design Principles

Learning and instructional principles derived from research and theory may help educators and instructional designers ground the design of their training and educational programs. They may also be used to set design standards, specify design requirements, and define guidelines for large scale instructional design initiatives. A set of learning and instructional design principles are compiled here to facilitate such processes.

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Universal Principles of Experiential Learning
(Lindsey & Berger, 2009)

Experiential approaches to teaching and learning are based on two central principles originally posited by Dewey in 1920's and 30's: (a) continuity (the idea that students learned from their experiences), and (b) interaction (the notion that students' experiences were derived from their interactions with the environment and other individuals) (Dewey, 1938, p. 25). Experiential learning is also grounded in the belief that children, adolescents and adults learn best when presented with relevant, meaningful and interesting goals, and foster skill development and the learning of facts, concepts, procedures, and principles in context of how they will be used.

The apparent merits of experiential learning has resulted in a number of recent models, including, but not limited to those posited by Kolb (Kolb, 1984; Kolb & Fry, 1975), Schank, Berman and Macpherson (1999) and Clark (2005, 2008). With the plethora of interpretations, Lindsey and Berger (2009) synthesized published approaches, identifying four central tenets of experiential learning to guide research and practice (i.e., learning should be student-centered rather than teacher-directed, focus on real-world experiences, include a high degree of self-direction for decision-making, and consist of feedback regarding the decisions made by the student) and three universal and sequential principles of experiential learning.

Principle 1 - Framing the Experience. The first phase includes communicating the instructional objectives, assessment criteria, expected behaviors, and social structure (with peers, instructors and the environment beyond the class). Variable methods such as didactic instruction may also occur in this phase to provide the foundational knowledge required to successfully engage in and interpret the experience.

Principle 2 - Activating Experience. Activating prior as well as newly initiated experiences are necessary. There are multiple methods for activating experience ranging from laboratory practice to simulations. Key characteristics of activating experience include: (a) providing an authentic experience to facilitate transfer; (b) making decisions that have authentic outcomes; (c) problem orientation so learners clearly perceive and accept the relevance of the specific learning activities in relation to the larger talk problem; and (d) present optimal difficulty to challenge the student but not so difficult that the student does not have a reasonable expectation for success.

Principle 3 - Reflecting on Experience. Experience must be analyzed to learn from it. Reflection should involve students answering the questions, "What happened?" "Why did it happen?" "What did I learn?" and "How would I apply this knowledge to future experiences?" Specific methods for stimulating reflection include: (a) teacher facilitation to help learners to identify their beliefs and working with them to master impediments to understanding; and (b) community building which is a part of framing the experience but should be pursued prior to reflecting. A significant element of community building is communicating the equality of the participants and their role in the active critique of others' experience.

Adult Learning Principles
(Knowles, 1970)

1. **Adults tend to be self-directed.** Adults want to participate in the planning and evaluation of their learning.
2. **Adults have rich reservoir of experience.** Adults prefer to build on prior learning and experience.
3. **Adults need to learn experientially.** Adult learn by doing; experiences form bases for knowledge construction.
4. **Adults have problem-solving orientation.** Adults are problem-centered rather than content-oriented
5. **Adults' motivation affected by need to know**. Adults most interested if learning has immediate relevance to job or personal life
6. **Adults motivated by internal/intrinsic factors.** Grades and other extrinsic rewards not as effective with adults.

Adult [Instructional] Design Principles:

1. **Control**. Adults need to be involved in the planning and evaluation of their instruction
2. **Prior Knowledge**. Instruction should stimulate prior knowledge and relate to prior experiences.
3. **Experiential**. Experience (including mistakes) provides the basis for learning activities
4. **Problem-based**. Adult learning is problem-centered rather than content-oriented
5. **Relevance**. Adults are most interested in learning about subjects that have immediate relevance to their job or personal life

Prior Knowledge & Experience (Briefcase):

1. Life experience (including life altering events that affect cognitive abilities)
2. Work experience (including development of thinking patterns based on this experience)
3. Positive/negative previous adult learning experiences
4. Performance affectors, including cognitive abilities
5. Time between learning interactions
6. Aging factors

Learner-Centered Psychological Principles
(APA, 1997)

Cognitive and Metacognitive Factors

1. *Nature of the learning process***.** The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.

2. *Goals of the learning process.* The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.

3. *Construction of knowledge*. The successful learner can link new information with existing knowledge in meaningful ways.

4. *Strategic thinking.* The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.

5. *Thinking about thinking.* Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.

6. *Context of Learning.* Learning is influenced by environmental factors, including culture, technology, and instructional practices.

Motivational and Affective Factors

7. *Motivational and emotional influences on learning.* What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states.

8. *Intrinsic motivation to learn.* The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.

9. *Effects of motivation on effort.* Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without the learner's motivation to learn, the willingness to exert this effort is unlikely without coercion.

Developmental and Social Factors

10. *Developmental influences on learning.* As individuals develop, there are different opportunities and constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

11. *Social influences on learning.* Learning is influenced by social interactions, interpersonal relations, and communication with others.

Individual Differences

12. *Individual differences in learning.* Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.

13. *Learning and diversity.* Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.

14. *Standards and assessment.* Setting appropriately high and challenging standards and assessing the learner as well as learning progress—including diagnostic, process, and outcome assessment—are integral parts of the learning process.

Cognitive Constructivist Teaching Practices and Principles
(Bonk & King, 2009)

1. ***Mind**:* The mind is in the head; hence, the learning should focus on active cognitive reorganization.

2. ***Raw Materials**:* Use raw or primary data sources, manipulatives, and interactive materials.

3. ***Student Autonomy**:* Ask students for personal theories and understandings before any instruction. Allow student thinking to drive lessons and alter instruction based on responses. Place thinking and learning responsibility in students' hands to foster ownership.

4. ***Meaningfulness and Personal Motivation**:* Make learning a personally relevant and meaningful endeavor. Relate learning to practical ideas and personal experiences. Adapt content based on student responses to capitalize on personal interests and motivation.

5. ***Conceptual Organization/Cognitive Framing**:* Organize information around concepts, problems, questions, themes, and interrelationships, while framing activities using thinking-related terminology (e.g., classify, summarize, predict).

6. ***Prior Knowledge and Misconceptions**:* Adapt the cognitive demands of instructional tasks to students' cognitive schemes, while building on prior knowledge. Design lessons to address students' previous misconceptions, for instance, by posing contradictions to original hypotheses and then inviting responses.

7. ***Questioning**:* Promote student inquiry and conjecture with open-ended questions. Also, encourage student question-asking behavior and peer questioning.

8. ***Individual Exploration and Generating Connections**:* Provide time for the selection of instructional materials and the discovery of information, ideas, and relationships. Also, includes encouraging students to generate knowledge connections, metaphors, personal insights, and build their own learning products.

9. ***Self-Regulated Learning**:* Foster opportunity for reflection on skills used to manage and control one's learning. Help students understand and become self-aware of all aspects of one's learning, from planning to learning performance evaluation. Given the focus on individual mental activity, the importance of cooperative learning or peer interaction is in the modeling of and support for new individual metacognitive skill.

10. ***Assessment**:* Focus of assessment is on individual cognitive development within predefined stages. Use of authentic portfolio and performance-based measures with higher order thinking skill evaluation criteria or scoring rubrics.

Social Constructivist Teaching Practices and Principles
(Bonk & King, 2009)

1. ***Mind**:* The mind is located in the social interaction setting and emerges from acculturation into an established community of practice.

2. ***Authentic Problems**:* Learning environments should reflect real-world complexities. Allow students to explore specializations and solve real-world problems as they develop clearer interests and deeper knowledge and skills.

3. ***Team Choice and Common Interest**:* Build not just on individual student prior knowledge, but on common interests and experiences. Make group learning activities relevant, meaningful, and both process and product oriented. Give students choice in learning activities. Foster student and group autonomy, initiative, leadership, and active learning.

4. ***Social Dialogue and Elaboration**:* Use activities with multiple solutions, novelty, uncertainty, and personal interest to promote student-student and student-teacher dialogue, idea sharing and articulation of views. Seek student elaboration on and justification of their responses with discussion, interactive questioning, and group presentations.

5. ***Group Processing and Reflection**:* Encourage team as well as individual reflection and group processing on experiences.

6. ***Teacher Explanations, Support, and Demonstrations**:* Demonstrate problems steps and provide hints, prompts, and cues for successful problem completion. Provide explanations, elaborations, and clarifications where requested.

7. ***Multiple Viewpoints**:* Foster explanations, examples, and multiple ways of understanding a problem or difficult material. Build in a broad community of audiences beyond the instructor.

8. ***Collaboration and Negotiation**:* Foster student collaboration and negotiation of meaning, consensus building, joint proposals, prosocial behaviors, conflict resolution, and general social interaction.

9. ***Learning Communities**:* Create a classroom ethos or atmosphere wherein there is joint responsibility for learning, students are experts and have learning ownership, meaning is negotiated, and participation structures are understood and ritualized. Technology and other resource explorations might be used to facilitate idea generation and knowledge building within this community of peers. Interdisciplinary problem-based learning and thematic instruction in incorporated wherever possible.

10. **Assessment**: Focus of assessment is on team as well as individual participation in socially organized practices and interactions. Educational standards are socially negotiated. Embed assessment in authentic, real-world tasks and problems with challenges and options. Focus on collaboration, group processing, teamwork, and sharing of findings. Assessment is continual, less, formal, subjective, collaborative, and cumulative.

Sociocultural Theory and Principles for
Computer Supported Collaborative Learning (CSCL) Environments
(Bonk & King, 2009)

- *Mediation:* According to sociocultural theories, genetic or developmental analyses need to be used to understand the origins and transitions of mental functions; there are four levels of development: Microgenetic, ontogenetic, phylogenetic, and sociohistorical. From this view, social and individual psychological activity is influenced or mediated by the tools and signs in one-s sociocultural milieu (e.g., written language, maps, artwork, diagrams, computer screens, etc.). Because individual development is dependent on institutional settings and cultural artifacts in one's learning environment, as technology advances to alter the available cultural tools and settings, so, too, does it alter mind.

- *Zones of Proximal Development (ZPD):* This term refers to the distance between actual or independent problem solving and performance when provided with learning assistance from adults or more capable peers. It assumes that social interaction is central to the development of new patterns of thought and strategic behaviors; hence, if computer tools can be considered a more capable peer, they might mediate new patterns of thought within one'' ZPD.

- *Internalization:* Sociocultural theorists believe that development appears twice, once socially with others and later as independent problem-solving behavior; in other words, it moves from an external to an internal plane. Internalization, therefore, is the process of taking new information that was experienced or learned within a social context and developing the necessary skills or intellectual functions to independently apply the new knowledge and strategies. Private or inner speech is important to development because it can be a bridge for the internalization of self-regulatory behaviors. A key assumption here is that learning is not an exact copying process, but, instead, the learner appropriates or applies the skills or information based in his or her own skills, needs, and experiences.

- *Cognitive Apprenticeship:* Refers to a socially interactive relationship similar to the master-apprentice one in skilled trades and crafts. The concept assumes that newcomer learners should be acculturated into an established community of practice by observing and participating on the periphery. Teachers and communities, therefore, should apprentice and scaffold young learns into authentic learning activities, while gradually ceding control of the learning task to the student. Hence, novice learners move from the fringes of the culture to a more central role within it.

- *Assisted Learning:* Because learning precedes development, effective instruction can provoke developmental growth or rouse new skills to life. As a result of this malleability of intelligence to instruction, teachers are vital in creating learning environments rich in meaning making and social negotiation activities. There are a range of techniques for teachers to assist in the learning process (e.g., modeling, coaching, scaffolding and fading, questioning, directly instructing, task structuring, management and feedback, and pushing students to explore, reflect, and articulate ideas).

- *Teleapprenticeship:* As a result of advances in technology tools, there are a myriad of online learning environments that are mediated by experts, peers, mentors, teachers, and so on, to help learners and teachers build and share knowledge through access to specialized expertise and information.

- *Scaffolded Learning:* This term relates to the various forms of support of assistance provided to a learner by an expert or more capable peer that enables the learner to complete a task or solve a problem that would not have been possible without such support. Scaffolding could include hinting, elaborating, guiding, questioning, prompting, probing, simplifying, or other similar learning supports. The goal is to actively engage the learner while providing only the necessary supports for eventual independent use of such strategies.

- *Intersubjectivity:* This concept refers to a temporary shared collective reality among individuals. Conferencing and collaborative technologies can foster such shared space or situational understanding between learning participants that can help them negotiate meaning, design new knowledge, and perceive multiple problem-solving perspectives.

- *Activity Setting as Unit of Analysis:* Sociocultural theorists argue that the proper unit analysis for research should be the activity or word meaning. Specific circumstances of an event or activity are essential to understanding how people act in their attempt to reach their goals. In effect, because consciousness is a product of society, we should explore the individual-in-social action.

- *Distributed Intelligence in a Learning Community:* Student higher order mental functioning has its roots in social relations. The mind, therefore, is distributed in society, and extends beyond one's skin. Because knowledge is negotiated by members of a community of practice, the classroom should be organized to guide student learning toward membership in a learning community. Participation in such a classroom is no longer didactic or transmissive, but a sophisticated instructional conversation. Though technology is vital here, it is but one resource of a learning community; other resources that should also be utilized include: experts, mentors, peers, curriculum/textbooks, teachers, self-reflection, assessment, parents, and the funds of capital within one's local community.

Brain-Based (Natural) Learning Principles
(Caine, Caine, McClintic & Klimek, 2005)

Caine and Caine (2007) conclude that "Optimizing the use of the human brain means using the brain’s infinite capacity to make connections–and understanding what conditions maximize this process." They identify three interactive and mutually supportive elements that should be present in order for complex learning to occur: "relaxed alertness," "orchestrated immersion," and "active processing."

1. An optimal state of mind that we call **relaxed alertness**, consisting of low threat and high challenge.

2. The **orchestrated immersion** of the learner in multiple, complex, authentic experience.

3. The regular, **active processing** of experience as the basis for making meaning.

By addressing the twelve principles of Brain-Based Learning (BBL), educators and instructional designers create the three conditions necessary for complex learning to occur.

Relaxed Alertness:
- Principle 11: Complex learning is enhanced by challenge and inhibited by threat associated with helplessness and fatigue.
- Principle 2: The brain/mind is social.
- Principle 3: The search for meaning is innate.
- Principle 5: Emotions are critical to patterning.

Orchestrated Immersion in Complex Experience:
- Principle 6: The brain/mind processes parts and wholes simultaneously.
- Principle 1: All learning engages the physiology.
- Principle 4: The search for meaning occurs through patterning.
- Principle 10: Learning is developmental.

Active Processing:
- Principle 9: There are at least two approaches to memory. One is to store or archive isolated facts, skills, and procedures. The other is to simultaneously engage multiple systems in order to make sense of experience.
- Principle 7: Learning involves both focused attention and peripheral perception.
- Principle 8: Learning is both conscious and unconscious.
- Principle 12: Each brain is uniquely organized.

Brain Rules
(Medina, 2014)

In Brain Rules, Dr. John Medina, a molecular biologist, shares his lifelong interest in how the brain sciences might influence the way we teach adults and children, and the way we work. He describes 12 brain rules: What scientists know about how our brains work.

- **Survival:** The human brain evolved. The brain is a survival organ. It is designed to solve problems related to surviving in an unstable outdoor environment. The strongest brains survive, not the strongest bodies
- **Exercise:** Exercise boosts brain power. The human brain evolved under conditions of almost constant motion. From this, one might predict that the optimal environment for processing information would include motion..
- **Sleep:** Sleep well, think well. When we're asleep, the brain is not resting at all. It is almost unbelievably active! Loss of sleep hurts attention, executive function, working memory, mood, quantitative skills, logical reasoning, and even motor dexterity.
- **Stress:** Stressed brains don't learn the same way. Your brain is built to deal with stress that lasts about 30 seconds. The brain is not designed for long term stress when you feel like you have no control. You can actually watch the brain shrink.
- **Wiring:** Every brain is wired differently. What YOU do and learn in life physically changes what your brain looks like – it literally rewires it. We used to think there were 7 categories of intelligence, but may number more than 7 billion.
- **Attention:** We don't pay attention to boring things. What we pay attention to is profoundly influenced by memory. Our previous experience predicts where we should pay attention. Culture matters too.
- **Memory:** Repeat to remember. The brain can only hold about seven pieces of information for less than 30 seconds! To extend the 30 seconds to a few minutes or even an hour, you will need to consistently re-expose yourself to the information.
- **Sensory Integration:** Stimulate more of the senses. Our senses work together! Those in multisensory environments always do better than those in unisensory environments.
- **Vision:** Vision trumps all other senses. We are incredible at remembering pictures. Our brain sees words as lots of tiny pictures, and we have to identify certain features in the letters to be able to read them. That takes time.
- **Music:** Study or listen to boost cognition. Ideas about how music affects the brain long have been the providence of anecdote. But the research has been maturing for a while now.
- **Gender:** Male and female brains are different. By more than 2 to 1, women are more likely to get depressed than men, a figure that shows up just after puberty and remains stable for the next 50 years. Males exhibit more antisocial behavior.
- **Exploration:** We are powerful and natural explorers. The desire to explore never leaves us despite the classrooms and cubicles we are stuffed into. We learn, not by passive reaction to the environment but by active testing through observation, hypothesis, experiment, and conclusion.

First Principles of Instruction
(Merrill, 2013)

Regardless of model or method, instructional design theories, models and research indicate that instruction to address the following principles to facilitate learning.

Principle 1: Demonstration Principle. Instruction should: (a) provide a demonstration of the skill consistent with the type of component skill (i.e., kinds of, how-to, and what-happens); (b) provide guidance that relates demonstration to generalities; (c) engage learners in peer discussion and peer demonstration; and (d) allow learners to observe demonstration through media that are appropriate to the content.

Principle 2: Application Principle. Instruction should: (a) have learners apply learning consistent with the type of component skill (i.e., kinds of, how-to, and what-happens); (b) provide intrinsic or corrective feedback; (c) provide coaching, which should be gradually withdrawn to enhance application; and (d) engage learners in peer collaboration.

Principle 3: Task-Centered Principle. Instruction should (a) use a task-centered instructional strategy, and (b) use progression of increasingly complex whole tasks.

Principle 4: Activation Principle. Instruction should: (a) activate relevant cognitive structures in learners by having them recall, describe or demonstrate relevant prior knowledge of experience; (b) have learners share previous experiences with each other; and (c) have learners recall or acquire a structure for organizing new knowledge.

Principle 5: Integration Principle. Instruction should: (a) integrate new knowledge into learners' cognitive structures by having them reflect on, discuss, or defend new knowledge or skills; (b) engage learners in peer critiques; (c) have learners create, invent, or explore personal ways to use their new knowledge or skill; and (d) have learners publicly demonstrate their new knowledge.

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