Cognitive Science

Understanding of:
- Human Memory
- Encoding & Retrieval Processes
- Cognitive Processes in Learning
- Mental Models, Schemata
- Theories of Multimedia Learning

Overview
- Behaviorism
- Cognitivism
- Constructivism
- Ausubel’s Meaningful Reception Learning Theory
- Schema Theory
- Application to the design of technology-based instruction
Learning Theories

Overview

Human Cognitive Architecture

Learning Theories

Behaviorism

Metaphor
Learning as response acquisition
Brain as ‘black box’

Learner
Passive in learning process

Goal of Instruction
Increase number of correct behaviors

Learning Outcome
Amount of behavior change

Example
Drill & practice
Learning Theories

Behaviorism

Skinner/Thorndike

– Respondent behavior: Involuntary behavior in reaction to stimulus (Pavlov)
– Operant behavior: Emitted by organism
– Reinforcement: Stimulus – Response – Stimulus
discriminative operant contingent

Shaping/Chaining

– Shaping: reinforcement of successive approximations of goal behavior
– Chaining: establish complex behaviors made up of discrete, simpler behaviors already known to learner

Learning Theories

Cognitivism

Metaphor

Learner

Goal of Instruction

Learning Outcome

Example

Cognitivism

Metaphor

Learning as knowledge acquisition

Brain: transforming and processing function

Learner

Processor of information

Goal of Instruction

Increase amount of knowledge

Learning Outcome

Amount of knowledge acquired

Example

Multiple-choice reading comprehension test
Cognitive Science

Reception Learning Theory

Ausubel

- Reception learning (expository instruction)
- Discovery learning (experiments, labs,...)
- Rote learning
- Meaningful learning

Meaningful Learning

Ausubel

- Cognitive Structures: Set of ideas organized in hierarchical structure (propositional model with hierarchy)
- Anchoring ideas: specific, relevant ideas in the learner’s cognitive structure that provide the entry points for new information to be connected

Derivative subsumption: learning of new examples or cases that are illustrative of an established concept or previously learned proposition, existing idea remains unchanged

Correlative Subsumption: elaboration, extension or modification of previously learned concepts or propositions by the subsumption of the incoming idea; existing idea is changed/expanded through new idea
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**Meaningful Learning**

**Superordinate learning**: synthesis of established ideas. New, inclusive proposition or concept is learned under which already established ideas can be subsumed.

**Combinatorial learning**: new concept or idea is neither more inclusive nor subordinate to relevant anchoring ideas in cognitive structure. New idea is not relatable in a specific sense to an existing anchor but is generally relevant to a broad background of information.

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**Meaningful Learning**

**Definition: Schema**

– Data structure for representing the generic concepts stored in memory

– Represent our knowledge about all concepts: underlying objects, situations, events, sequences of events, actions, and sequences of actions (Rumelhart, 1980)

– Mental models are schemata that not only represent one’s knowledge about a subject matter but also include perceptions of task demands and task performances; guide and govern performance.

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**Meaningful Learning**

**Mental Models**

– Mental models are incomplete

– People’s abilities to control their models is limited

– Mental models are unstable

– Mental models do not have firm boundaries

– Mental models are unscientific

– Mental models are parsimonious

Norman (1983)
Meaningful Learning

Schema acquisition and modification

**Accretion**: similar to fact learning, information is remembered that was instantiated within a schema as a result of text comprehension or understanding an event

**Tuning**: existing schemata become more consistent with experience, incorporates minor schema modifications

Restructuring: Creation of entirely new schema which replace or incorporate old ones;

**Schema induction** – new schema is configured from repeated consistencies of experience; or: restructuring through **learning by analogy**, new schema is modeled after existing one and then tuned

Advance organizer (Ausubel, 1968)

- Relevant and inclusive introductory materials, provided in advance of learning materials
**Advance organizer (Mayer, 1979)**

- Have a short set of verbal and visual information
- Be present prior to learning of a larger body of to-be-learned information
- Contain no specific content from the to-be-learned information

**Meaningful Learning**

- Means of generating logical relationships among elements of new information,
- Influence learner’s encoding process:
  - Provide a new general organization as an assimilative context
  - Activate a general organization from learner’s existing knowledge that would not have normally been used to assimilate the new material

**Question**

- What is the fundamental difference between objectivist and constructivist epistemologies?
Learning Theories

Paradigms

Constructivism
- Knowledge is subjective
- Meaning is rooted in, and indexed by, experience

Objectivism
- ‘Objective’ knowledge exists
- Insignificant role of experiences

Learning Theories

Scenario

Learning Theories

Constructivism

Metaphor
- Learning as knowledge construction; Brain: Closed system without informational input and output

Learner
- Constructor of meaning

Goal of Instruction
- Develop learning and thinking strategies

Learning Outcome
- How does student structure and process knowledge?

Example
- Anchored Instruction
How can Ausubel's Meaningful Reception Learning Theory and Schema Theory be used to inform the design of meaningful learning for the following projects?

1. Design multimedia software to introduce medical students to human anatomy.
2. Design multimedia instruction to train experienced Airline Pilots on the navigational instruments of a new type of airplane.
3. Design multimedia instruction to teach university students in the history of the American civil war.