LECTURE 2: LEARNING THEORIES - APPLICATION TO COMPUTER STUDIES

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Definition of terms

- **Learning:** This is the act of acquiring new, or modifying and reinforcing, existing knowledge, attitude or behaviors, skills and values.
- **Learning theory**: are conceptual frameworks describing how information is absorbed, processed, and retained during **learning**. Cognitive, emotional, and environmental influences, as well as prior experience, all play a part in how understanding, or a world view, is acquired or changed and knowledge and skills retained.

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General learning theories

- **Behaviorism**
- **Cognitivism**
- **Constructivism**
- **Social Learning Theory**
- **Social Constructivism**
- **Multiple Intelligences**
- **Brain-Based Learning**
- **Andragogy**

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Representations of the Learning Process

- Behaviorism
  - ✓Stimulus-Response
  - ✓Reinforced Behavior
  - ✓Antecedent Behavior Consequence
  - ✓Sequenced knowledge and skills presented in logical limited steps
- Cognitivism
  - ✓Cognitivist Learning Perspective
  - ✓Information Processing
  - ✓Schema
  - ✓Mental Models
- Constructivism
  - ✓Inquiry-based
  - ✓Discovery learning

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Relevant Frameworks

- Behaviorism
  - ✓Programmed Instruction (logical presentation of content, overt responses, immediate knowledge of correctness)
- Cognitivism
  - ✓Events of Instruction (Conditions of Learning)
- Constructivism
  - ✓Cognitive Apprenticeship
  - ✓Cognitive Flexibility
  - ✓Situated Learning
  - ✓Zone of Proximal Development

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Key Principles: Behaviorism

- Learning happens when a correct response is demonstrated following the presentation of a specific environmental stimulus
- Emphasis is on observable and measurable behaviors

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Key Principles: Cognitivism

- Learning is a change of knowledge state
- Knowledge acquisition is described as a mental activity that entails internal coding and structuring by the learner.
- Learner is viewed as an active participant in the learning process
- Emphasis is on the building blocks of knowledge (e.g. identifying prerequisite relationships of content)
- Emphasis on structuring, organizing and sequencing information to facilitate optimal processing

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Key Principles: Constructivism

- **Learners build personal interpretation of the world based on experiences and interactions**
- **Knowledge is embedded in the context in which it is used (authentic tasks in meaningful realistic settings)**
- **Create novel/new and situation-specific understandings by "assembling" knowledge from diverse sources appropriate to the problem at hand (flexible use of knowledge)**

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Goal of Instruction: Behaviorism

- **Communicate or transfer behaviors representing knowledge and skills to the learner (does not consider mental processing)**
- **Instruction is to elicit the desired response from the learner who is presented with a target stimulus**
- **Learner must know how to execute the proper response as well as the conditions under which the response is made**
- **Instruction utilizes consequences and reinforcement of learned behaviors**

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Goal of Instruction: Cognitivism

- **Communicate or transfer knowledge in the most efficient, effective manner (mind-independent, can be mapped onto learners)**
- **Focus of instruction is to create learning or change by encouraging the learner to use appropriate learning strategies**
- **Learning results when information is stored in memory in an organized, meaningful way.**
- **Teachers/designers are responsible for assisting learners in organizing information in an optimal way so that it can be readily assimilated**

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Goal of Instruction: Constructivism

- Build personal interpretations of the world based on individual experiences and interactions (constantly open to change, cannot achieve a predetermined, "correct" meaning, knowledge emerges in relevant contexts)
- Learning is an active process of constructing rather than acquiring knowledge
- Instruction is a process of supporting knowledge construction rather than communicating knowledge
- Do not structure learning for the task, but engage learner in the actual use of the tools in real world situations

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Instructional/Learning Strategies: Behaviorism

- **Behaviorism**
  - ✓**Instructional cues/prompts to elicit correct response**
  - ✓**Practice is paired with target stimuli**
  - ✓**Reinforcement for correct responses**
  - ✓**Building fluency (get responses closer and closer to correct response)**
  - ✓**Multiple opportunities/trials (Drill and practice)**
  - ✓**Discrimination (recalling facts)**
  - ✓**Generalization (defining and illustrating concepts)**
  - ✓**Associations (applying explanations)**
  - ✓**Chaining (automatically performing a specified procedure)**

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Instructional/Learning Strategies: Cognitivism

- Information Processing Model
- Explanations
- Demonstrations
- Illustrative examples
- Matched non-examples
- Corrective feedback
- Outlining
- Mnemonics
- Dual-Coding Theory
- Chunking Information
- Repetition
- Concept Mapping
- Advanced Organizers
- Analogies
- Summaries
- Interactivity
- Synthesis

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Instructional/Learning Strategies: Constructivism

- Modeling
- Collaborative Learning
- Coaching
- Scaffolding
- Problem-Based Learning
- Authentic Learning
- REALs
- Anchored Instruction
- Object-based Learning

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Theorists

- Behaviorism
  - Skinner
  - Bandura
  - Thorndike
  - Pavlov
- Cognitivism
  - Gagne
  - Bruner
  - Anderson
  - Gardner
  - Novak
  - Rummelhart
  - Norman
- Constructivism
  - Vygotsky
  - Lave & Wenger
  - Piaget
  - Bransford, Hasselbring,etc. (CTGV)
  - Grabinger
  - Spiro and colleagues

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Constructivist Theory

Jerome Bruner

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Constructivist Theory

- Learning is an active process in which learners discover and construct new ideas/concepts based on their current/prior knowledge.
- The issues that guide this process must be personally or societally relevant. Bruner believed that the learner selects information, constructs ideas based on that information and makes decisions by relying on their own cognitive structure of information.

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Constructivist Theory

- Bruner believed that instruction should allow the learner to discover principles for themselves through active dialog. Instructors should become information facilitators instead of information transmitters.

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Constructivist Theory

- Instruction should address four major aspects:
  1. Predisposition toward learning
  2. The ways in which knowledge can be structured so that it is readily grasped by the learner
  3. Effective sequencing of the material
  4. The nature and pacing of rewards

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Constructivist Theory

- To Bruner, knowledge is the activity of the person in the content domain and learning is the struggling of the learner with the issues within that domain.

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Constructivist Theory

- Principles:
  1. Instruction must be concerned with the experiences and contexts that make the student willing and able to learn.
  2. Instruction must be structured so that it can be easily grasped by the student (spiral organization).
  3. Instruction should be designed to facilitate extrapolation and/or fill in the gaps (going beyond the information given).

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Cognitive Development

Jean Piaget

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Cognitive Development

- Piaget believed that cognitive development occurs through a sequence of successive qualitative changes in cognitive structures.

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Cognitive Development
Piaget's Four Stages:

- **Sensorimotor Stage (birth - 2 yrs):**
  - ✓actions become more intentional and integrated into patterns, there is an increased awareness of self and surroundings.
- **Preoperational Thought Stage (2 - 7yrs):**
  - ✓development of language and conceptual thought occurs.
- **Concrete Operations Stage (7-11yrs):**
  - ✓increased ability to apply logical thought to concrete problems, thinking is still primarily related to immediate experience.
- **Formal Operations Stage (11yrs on):**
  - ✓ability to apply logic to a variety of problems; higher order thinking occurs.

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Cognitive Development

Instructional Implications:

1. There should be plenty of opportunity for assimilation and accommodation in order for students to proceed from one stage to the next.
2. The richer the experience, the more elaborate the cognitive structure development.
3. Materials and activities should be geared for the appropriate level of cognitive development.

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Elaboration Theory

Reigeluth

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Elaboration Theory

- Elaboration Theory details a general model of organizing instruction from a simple to more complex structure.

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Elaboration Theory

- Features of the Model (Ragan & Smith, 1996):
  1. An epitome at the beginning of the instruction
  2. A learning-prerequisite sequence within each level of elaboration
  3. A learner-control format
  4. The use of analogies, summarizers and synthesizers.

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Elaboration Theory

- Courses can have three different structurings which are based on the goals of the course;
  1. **Conceptual:** A course structure that is based upon concepts. There are three types: parts, kinds, and matrices
  2. **Procedural:** A course structure where learning/teaching is based on knowing the procedures for how to do something. There are two different kinds of procedural knowledge: procedural order and procedural decision.
  3. **Theoretical:** A course structure where learning/teaching is based on theory. There are two types: theory that describes a natural phenomena (descriptive) and those that affect a desired outcome (prescriptive).

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Problem-Based Learning

Roger Schank

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Problem-Based Learning

- Learning that is situated around an event, case, problem, or scenario.

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Problem-Based Learning
Five Strategies for Using PBL (Duffy & Cunningham, 1996):

1. *The Problem as a Guide:* the problem is presented in order to gain attention prior to presenting the lesson.

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Problem-Based Learning
Five Strategies for Using PBL

2. *The Problem as an Integrator or Test:* the problem is presented after readings are completed and/or discussed -- these are used to check for understanding.

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Problem-Based Learning
Five Strategies for Using PBL

3. *The Problem as an Example:* the problem is integrated into the material in order to illustrate a particular principle, concept or procedure.

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Problem-Based Learning
Five Strategies for Using PBL

4. *The Problem as a Vehicle for Process:* the problem is used to promote critical thinking whereby the analysis of how to solve it becomes a lesson in itself.

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Problem-Based Learning
Five Strategies for Using PBL

5. *The Problem as a Stimulus for Authentic Activity:* the problem is used to develop skills necessary to solve it and other problems -- skills can include physical skills, recall of prior knowledge, and metacognitive skills related to the problem solving process. A form of authentic assessment of the skills and activity necessary in the content domain.

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Problem-Based Learning

- *Design PBL Instruction:*
  1. *Task Analysis:* analysis must take place not only within the content domain but should also determine the actual setting where the learning will be authentic.
  2. *Problem Generation:* The problems must be constructed so they include the concepts and principles that are relevant and they must be set in a real context.

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Problem-Based Learning

- *Learning Sequence:*
  1. Collaborative Analysis session where groups work together to solve the problem.
  2. Self-directed Learning where the students identify the information and resources that are necessary to solve the problem.

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Problem-Based Learning

- The instructor in PBL only **acts** as a **facilitator** to learning, instead of a transmitter of the necessary information.

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Problem-Based Learning

- *Assessment:* assessment of learning must occur within the context of the problems and should be in the form of both self assessment and peer assessment.

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Conditions of Learning

Robert Gagne

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Conditions of Learning

- Gagne's theory defines five major categories of learning that each require a different type of instruction in order for learning to occur.
- The five categories are:
  a) Verbal information,
  b) Intellectual skills,
  c) Cognitive strategies,
  d) Motor skills
  e) Attitudes

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Conditions of Learning
Nine events of Instruction
(Ragan & Smith, 1996)

1. Gain Attention
2. Inform the learner of the objective
3. Stimulate recall of prior knowledge
4. Present stimulus material
5. Provide learning guidance
6. Elicit performance
7. Provide feedback
8. Assess performance
9. Enhance retention and transfer

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Conditions of Learning

- Major Principles of Gagne's Theory (Kearsley, 1998)
  1. Different instruction is needed for different learning outcomes.
  2. Events of learning operate on the learner in ways that constitute conditions of learning.
  3. The specific operations that constitute instructional events are different for each type of learning outcome.
  4. Learning hierarchies define what intellectual skills are to be learned and a sequence of instruction.

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Assimilation Theory

David Ausubel

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Assimilation Theory

- *Assimilation Theory:* Concerned with how individuals learn large amounts of meaningful material
- The primary process in learning is that new information is related to relevant knowledge that is already existing in an individual's cognitive structure.

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Assimilation Theory

- The steps to this process are:
  1. **Subsumptive**: meaning and new examples are added to an existing concept
  2. **Superordinate**: ideas and concepts are sythesized and therefore new inclusive concepts are created
  3. **Combinatorial**: additional background is added to achieve a more global understanding of the concept.

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Assimilation Theory

- **Principles**:
  1. The most general ideas of a subject should be presented first and then progressively differentiated in terms of detail and specificity
  2. Instructional materials should attempt to integrate new materials with previously learned material by comparing new and old ideas and concepts.

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Meaningful Learning

David Ausubel

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Meaningful Learning

- Meaningful learning occurs when learners actively interpret their experience using internal, cognitive operations.
- Prior knowledge is the most significant in determining what new learning will occur.
- "The model of cognitive organization proposed for the learning and retention of meaningful materials assumes the existence of a cognitive structure that is hierarchically organized." (Ausubel, 1963, p. 217)

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Meaningful Learning
Key Concepts

- **Cognitive Structure**: the learner's overall memory structure or integrated body of knowledge
- **Anchoring Ideas**: the specific, relevant ideas in the learner's cognitive structure that provide the entry points for new information to be connected
- **Reception Learning**: the entire content of what is to be learned is presented to the learner in its final form.

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Meaningful Learning
Key Concepts

- **Discovery Learning**: learners are required to rearrange a given array of information, integrate it with existing cognitive structures, and reorganize the integrated combination in such a way as to create a desired end product.
- **Rote Learning**: the learner memorizes and makes no connection between what was known and what was memorized.
- **Meaningful Learning**: the process of relating potentially meaningful information to what the learner already knows in a substantive way.

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Meaningful Learning

- *Representational Learning:* learning the meanings of unitary symbols or words. This is the most basic form of learning and serves as a foundation for all other learning to occur.
- *Conception Learning:* knowing beyond representation -- understanding the critical attributes that surround a concept and differentiate it from other concepts.
- *Prepositional Learning:* the meanings of new ideas expressed in verbal prepositions are acquired -- individual words and concepts are now combined to form a new idea -- inferences are now being made by the learner.

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Meaningful Learning

- Cognitive structure and anchoring ideas within the cognitive structure are the prerequisites to meaningful learning.

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Social Development Theory
Zone of Proximal Development

Lev Vygotsky

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Social Development Theory

- Vygotsky believed that social interaction played a role in the development of cognition meaning learning could occur through social contact.

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Social Development Theory

- Vygotsky (1978) states "every function in the child's cultural development appears twice: first, on the social level, and then, later, on the individual level; first, between people, then inside the child."

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Social Development Theory

- Three types of Experience:
  1. **Historical**: knowledge through generations
  2. **Social**: knowledge obtained through contact with someone else
  3. **Adaptation**: knowledge obtained by acting on the environment

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Social Development Theory

- Vygotsky believed that all higher order functions begin as actual relations between individuals -- this should be focused on because it is unique to humans.

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Social Development Theory

- Four Assumptions about Learning:
  1. **Signalization**: something that is common to all organisms.
  2. **Signification**: humans have evolved to a different level; the stimulus is not the only thing connected to the response. A symbol system becomes part of the response. Meaning is assigned to an arbitrary stimulus
  3. **Biological**: part of the evolutionary process
  4. **Sociohistorical**: creation and use of a culturally based signs and symbol system.

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Zone of Proximal Development

- The distance between the actual developmental level that is reflected and the level that is accomplished - created in the interaction between adult and child.

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Zone of Proximal Development

- The basic premise is that the adult provides the support and scaffolding for the individual until the individual assimilates the knowledge into their own cognitive structure.
- The idea behind scaffolding is that the support system is gradually taken away as the learner begins to take over and understand the process.

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Cognitive Flexibility Theory

Rand Spiro

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Cognitive Flexibility Theory

- "The theory is largely concerned with transfer of knowledge and skills beyond their initial learning situation
- For this reason, emphasis is placed upon the presentation of information from multiple perspectives and use of many case studies that present diverse examples." (Kearsley, 1998)

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Cognitive Flexibility Theory Instructional Strategies (Grabinger, 1996)

1) CFT uses several cases and rich examples in their full complexity
2) CFT uses multiple forms of knowledge representation, providing examples in several kinds of media
3) CFT links abstract concepts to case examples and brings out the generalizable concepts and strategies applicable to other problems or cases
4) To avoid mistakes of oversimplification, CFT presents a number of examples to make apparent, rather than hide the variability of concepts and themes within the domain.

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Instructional Transaction Theory (ID2)

Merrill, Li and Jones

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Instructional Transaction Theory

- **Purpose**: In response to perceived limitations in existing instructional design models and theories, Merrill, Li and Jones have developed what is referred to as a **"second generation theory of instructional design"** whose purpose is to expedite the design of an **automated system** or "ID expert."

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Instructional Transaction Theory

- Reasons for ID2:
  1. To analyze, represent, and guide instruction to teach integrated sets of knowledge and skill
  2. To produce pedagogic prescriptions about selection and sequence of instruction
  3. To be an open system that can respond to new theory

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Instructional Transaction Theory Critical Concepts:

- **Instructional Transactions**: Instructional algorithms and patterns of learner interactions that have been designed to enable the learner to acquire a certain kind of knowledge or skill
- A mutual, dynamic interaction between the instructional system and the student in which there is an exchange of information.

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Instructional Transaction Theory Critical Concepts:

- **Transaction Shell**: the structure of a transaction that identifies the interactions, parameters and knowledge representations needs for a given class of transactions
- These shells can consist of 2 subsystems:
  - ✓an authoring environment and a
  - ✓delivery environment.

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Instructional Transaction Theory Critical Concepts:

- **Transaction Class**: a set of similar transaction shells which have similar interaction requirements and similar knowledge representation requirements.

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Instructional Transaction Theory Critical Concepts:

- **Transaction Family**: all of the transactions necessary to enable the learner to acquire all of the necessary knowledge and skill -- to establish an effective mental model.

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Instructional Transaction Theory Critical Concepts:

- **Enterprise Transaction**: a higher level interaction which provides direction of execution and integration of learning.

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Situated Learning

Jean Lave

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Situated Learning

- Learning is a function of the activity, context, and culture in which it occurs.
- All material that is taught should be situated in real-world contexts from the start. (Winn & Snyder, 1996, p.124)
- Cognitive Apprenticeships
- All instruction should mimic the real life situation in which that knowledge would be useful. This will enable learners to store information in such a way that is easily retrievable. (Wilson & Cole, 1996, p.606)

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Multiple Intelligence Theory

Howard Gardner

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Multiple Intelligence Theory

- The theory states that there are seven distinct forms of intelligence (recently an 8th was introduced) that each individual possesses to a different degree.

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Multiple Intelligence Theory

Eight Intelligences:

1. Verbal/Linguistic
2. Logical/Mathematical
3. Spatial
4. Bodily/Kinesthetic
5. Interpersonal
6. Intrapersonal
7. Musical
8. Naturalistic

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Multiple Intelligence Theory

Instructional Implications:

- Teaching/learning should focus on the strength (particular intelligences) of each person and assessment of learning should measure all forms, not just specific ones.

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Multiple Intelligence Theory

- Principles (Kearsley, 1998):
  1. Individuals should be encouraged to use their preferred intelligences in learning
  2. Instructional activities should appeal to different forms of intelligence
  3. Assessment of learning should measure multiple forms of intelligence.

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Component Display Theory

David Merrill

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Component Display Theory

- Component Display Theory is a conditions-based theory of instructional design that is an extension of Gagne's Conditions of Learning (Ragan & Smith, 1996).
- Use of this theory is promoted by Reigeluth as a means for designing instruction at the micro or lesson level in Elaboration Theory.

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Component Display Theory

- CDT classifies learning objectives in two dimensions: performance level (remember, use or find) and content type (facts, concepts, principles, or procedures) (Ragan & Smith, 1996).

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Component Display Theory

	Fact	*Concept*	*Procedure*	*Principle*
Find				
Use				
Remember				

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Component Display Theory

- Primary Presentation Forms: Content (generality or instance) and Approach (expository or inquisitory)
- Secondary Presentation Forms: Prerequisites, context, helps, representation, mnemonics, feedback.
- According to the theory, instruction is more effective when it contains all of the necessary primary and secondary presentation forms.

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Component Display Theory

- Principles (Kearsley, 1998):
  1. Instruction will be more effective if all three primary performance forms are present.
  2. Primary forms can be presented by either an explanatory or inquisitory learning strategy.
  3. The sequence of primary forms is not critical provided they are all present.
  4. Students should be given control over the number of instances or practice items they receive.

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Social Learning Theory Observational Learning

Albert Bandura

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Social Learning Theory

- **Social Learning Theory**: people are not driven by either inner forces or environmental stimuli in isolation; instead behaviors are learned through continuous interaction of personal and environmental determinants and all learning from direct experience occurs by observing other people's behavior. (Burton, Moore, & Magliaro, 1996).

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Observational Learning

- Observation Learning Process (Burton et al., 1996):
  - **Attention Processes**: determine what is selectively observed and extracted
  - **Retential Processes**: patterns of behavior are attended to and retained
  - **Motor Reproduction Processes**: the behavior is reproduced and refined on a basis of feedback.
  - **Motivation**: the behavior is more likely adopted if it is considered valuable or functional.

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Observational Learning

a) **Learn by watching:** you don't have to do something in order to learn it
b) **Abstract, decide, engage:** learners see something in the environment, abstract what they've seen, decide if it is important and then repeat the behavior.

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Social Learning Theory

- **Reciprocal Determinism**: Interpersonal and nonsocial environmental factors come together and the behavior of individuals occurs because of prior interactions with other people AND with the immediate environment. (Glover, Bruning, & Filbeck, 1983)

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Bloom's Taxonomy

Benjamin Bloom

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Bloom's Taxonomy

1) **Knowledge:** the remembering, identification or recall of previously learned material
2) **Comprehension:** the understanding of the material and its meaning -- the learner can put the material in their own words
3) **Application:** The use of learned material in new situations -- the learner can use and make an abstraction of the material in a concrete context

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Bloom's Taxonomy

4) **Analysis:** The breaking down of the material into its component parts so its organizational structure can be understood
5) **Synthesis:** Putting all of the pieces of the material together to form a whole -- the learner can put together old knowledge in new ways
6) **Evaluation:** the learner can make judgments based on their knowledge about the value of methods and materials for some purpose.

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Questions:

- Define the following terms: learning, teaching, learning theory
- Discuss the application of the following learning theories in computer studies;
  1. Behaviorism
  2. Cognitivism
  3. Social Learning Theory
  4. Social Constructivism
  5. Multiple Intelligences
  6. Brain-Based Learning, andragogy

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