

# Human Learning

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**SETH HORRIGAN**

**CS 260: SPRING 09**

# Today's Class

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- ~40 minutes of student presentation - today's topic
- Discussion and further details
- Group discussions
- Group presentations

# Last Class

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- Pragmatism
- Learning theory
  - Piaget, Vygotsky, and Constructivism
  - Activity theory

# Today's Topic

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- **Coming up**
  - 1/28/2009: Constructivism and Piaget
  - 2/2/2009: Designing for Unschooled Users
  - 2/9/2009: Vygotsky and Learning
  - 2/11/2009: Vygotsky: Genetic and Linguistic Theories

# How People Learn

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- National Research Council published How People Learn in 1999
  - Updated edition in 2004
  - How Children Learn is chapter 4 of the report

# Why Human Learning

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- Why study human learning in HCI?

# Why Children's Learning

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- Why study learning in children specifically?

# Infants' Capabilities

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- Infants as Tabula Rasa
  - Jean Piaget in 1920s
- Studies of how infants “integrate sight and sound and explore their perceptual worlds.”
- Children as active participants in learning
  - Vygotsky – social construction of learning

# Vygotsky and Piaget

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- Vygotsky and Piaget were leading educational theorists of 20<sup>th</sup> century
- Piaget – world explored is “natural”
- Vygotsky – world explored is social construct

# Piaget's stages

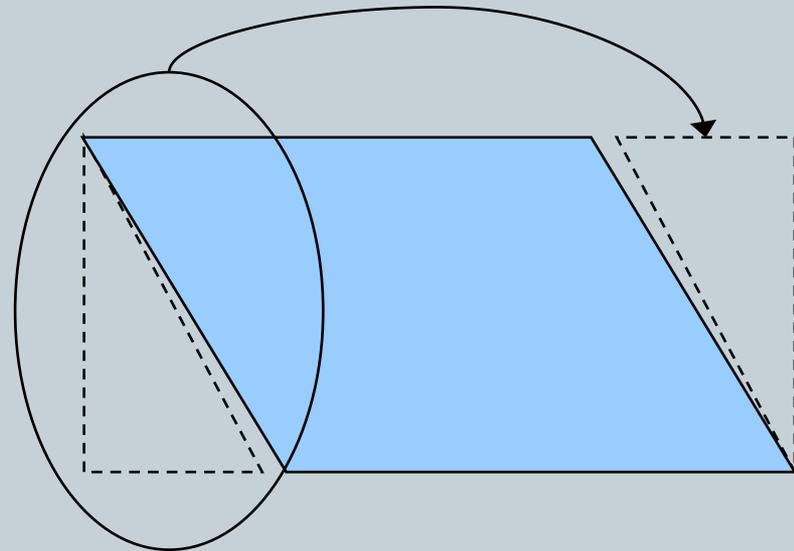
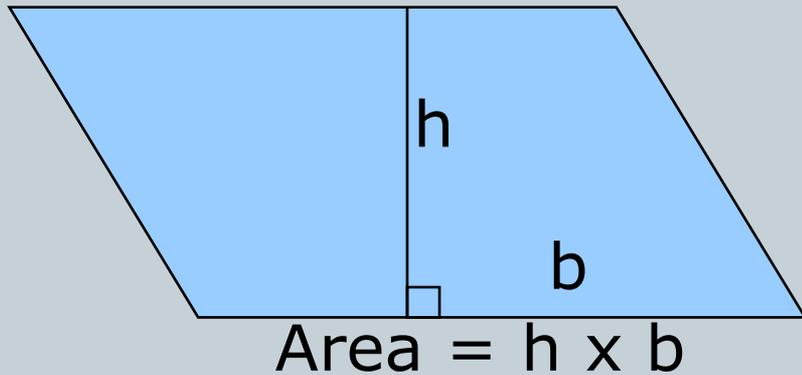
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- Piaget observed stages in child development
  - Sensori-motor (acting, observing, remembering)
  - Semiotic or symbolic (naming things)
  - Concrete operations (relationships, transformations)
  - Propositional or formal thought

# Formal Thought and Transfer

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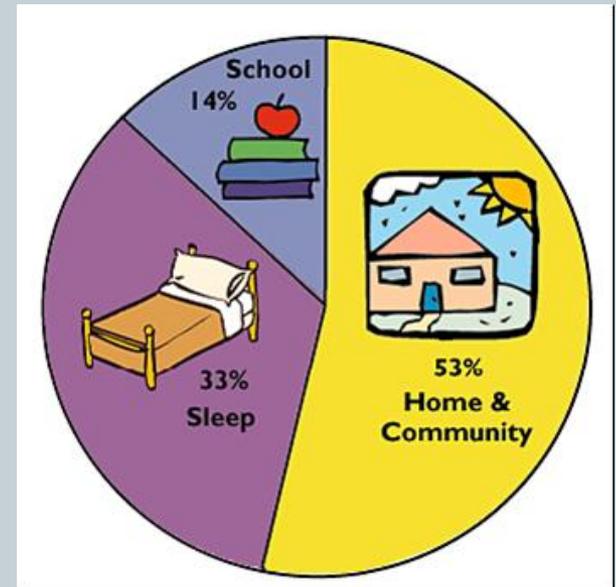
- Transfer



# Transfer

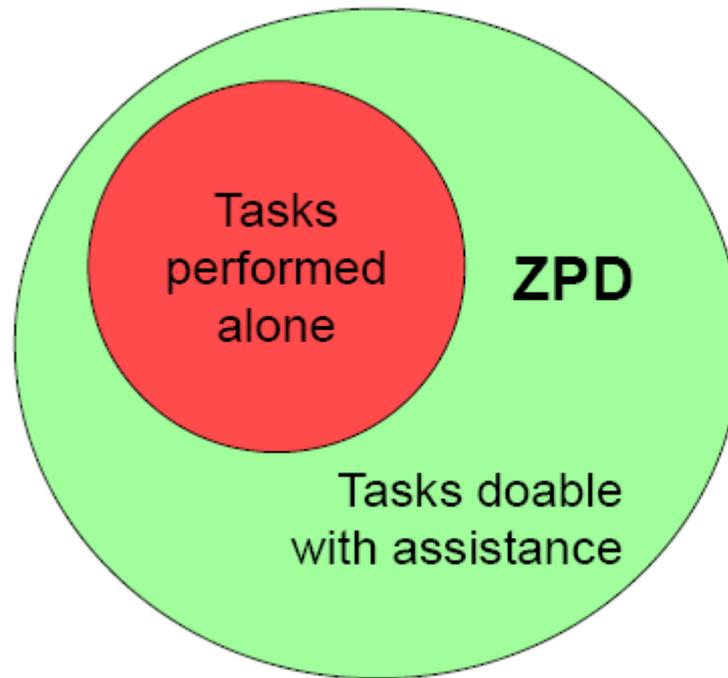
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- Building new knowledge from existing
  - Real-world experience
  - Existing understanding
  - Generality of earlier knowledge
  - Abstraction
  - Motivation
- People learn best by doing



# Transfer and Zone of Proximal Development

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Tasks that cannot be done at all

# Infant Learning

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- What is the ZPD for infants?
- Methodology from NRC reading
  - Non-nutritive sucking and habituation
  - Visual fixation

# Infant Learning

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- There are clear stages of learning
  - 5-7 month-olds: need point of contact
  - 10 month-olds: envision usage of tools
  - 24 month-olds: choose the best unattached tool

# Privileged Domains

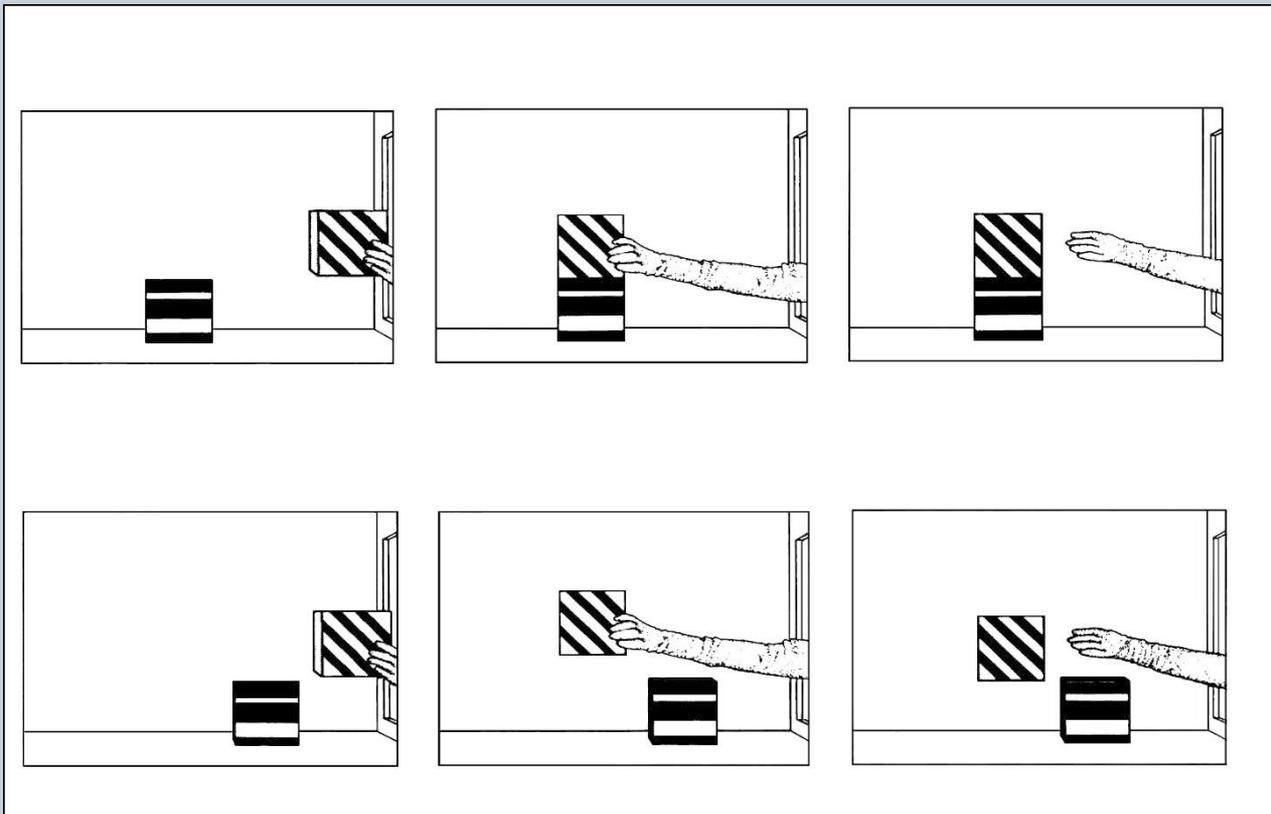
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- Physical Concepts
- Biological Causality
- Early Number Concepts
- Language

# Privileged Domains

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- Physical Concepts



# Privileged Domains

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- Biological Causality



# Privileged Domains

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- **Early Number Concepts**
  - 6-8 month olds with 2-item or 3-item photographic slides
  - Infants tracking 2 or 4 rabbit hops
  - 5 month olds surprised when addition does not yeild more
  - Note: this does not mean they understand number systems

# Privileged Domains

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- Language
  - 4 month olds prefer speech over other sounds
  - By 2 months, American infants react to English faster than French
  - 8-10 months recognize linguistically relevant contrasts
  - Understand language contextually
    - ✦ “Eat the apple” in the high-chair, “throw the apple” in playpen

# Intelligence

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- Gardner's seven types
  - Linguistic
  - Logical
  - Musical
  - Spatial
  - Bodily
  - Kinesthetic
  - Interpersonal and intrapersonal

# Intelligence

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- Entity theory
- Incremental theory
  - Supported by formative evaluations

# How Do People Improve

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- Strategies
- Meta-cognition

# Strategies

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- Rehearsal
- Elaboration
- Summarization
- Clustering

# Strategies

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- **Clustering**
  - Categorization where appropriate
  - Miller suggests that people generally can remember  $7 \pm 2$  items
  - This may be phonemes, symbols, numbers...

# Clustering

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- **BNBISRBCMCAAC**

# Clustering

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# Clustering

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- **IBMCBSNBCRCA**

# Clustering

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# Strategies

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- **Strategies develop and evolve**
  - “microgenetic” studies explore development of single concept
    1. Discoveries are made via success, not impasse or failure
    2. Transition strategies are short-lived but useful
    3. Generalization occurs slowly

# Metacognition

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- Self-regulation may appear early
- Self-reflection is later developing
- Metacognition is the learner's conscious awareness of their learning process
  - Limitations, strengths, strategies, connections
  - Determines how learning is managed, and leads to better transfer

# Metacognition

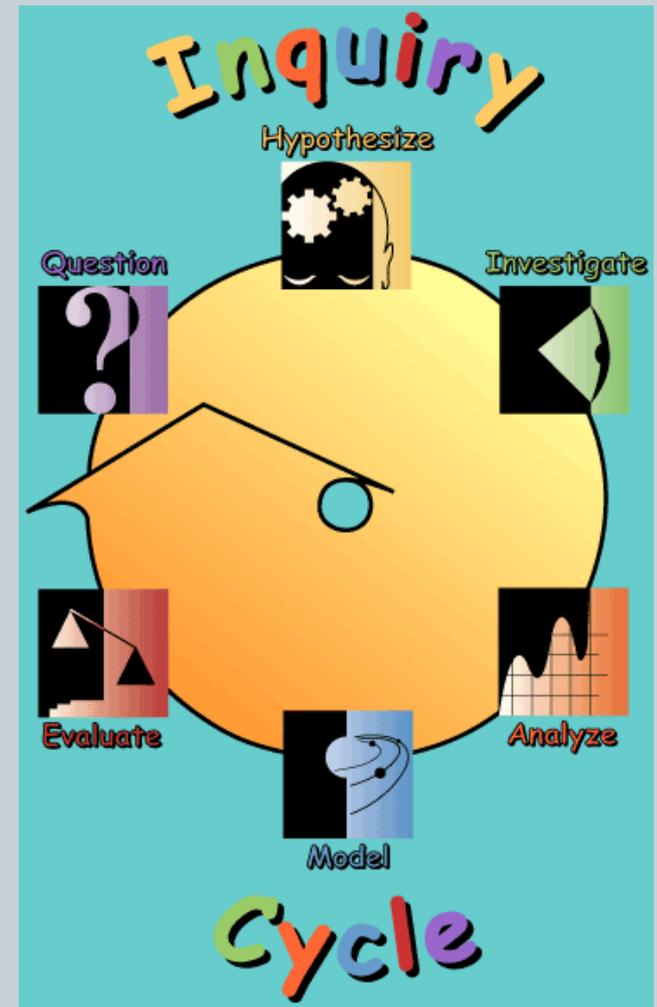
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- **Metacognition example**
  - Strong learners reading a textbook will pause regularly, check understanding, and go back to difficult passages
  - Weak learners may read through the entire text, then realize they don't understand and start again

# Metacognition

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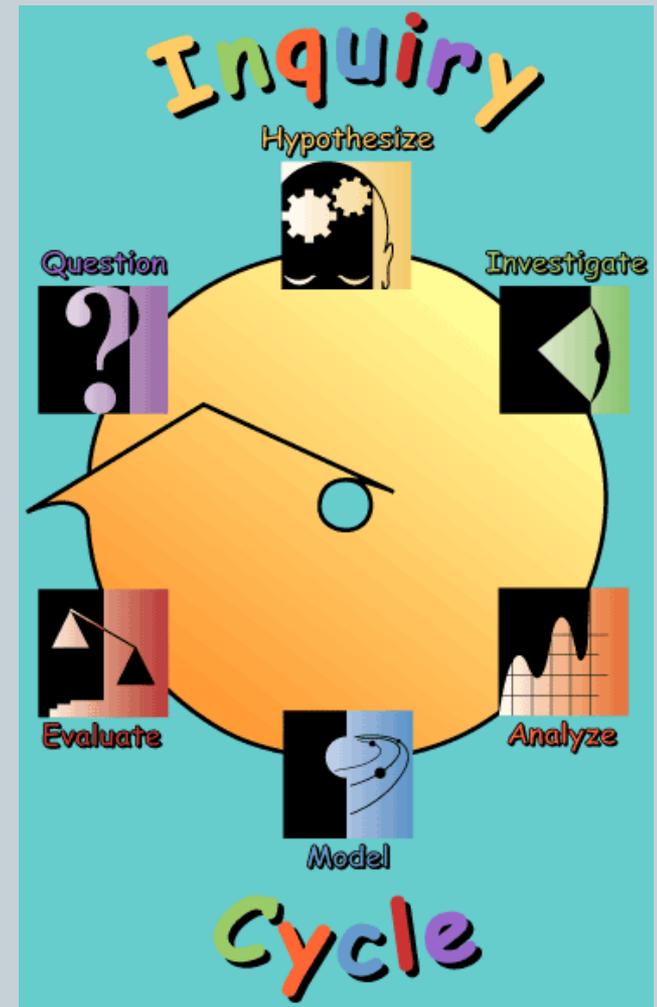
- Inquiry-based learning uses an explicit meta-cognitive strategy



# Metacognition

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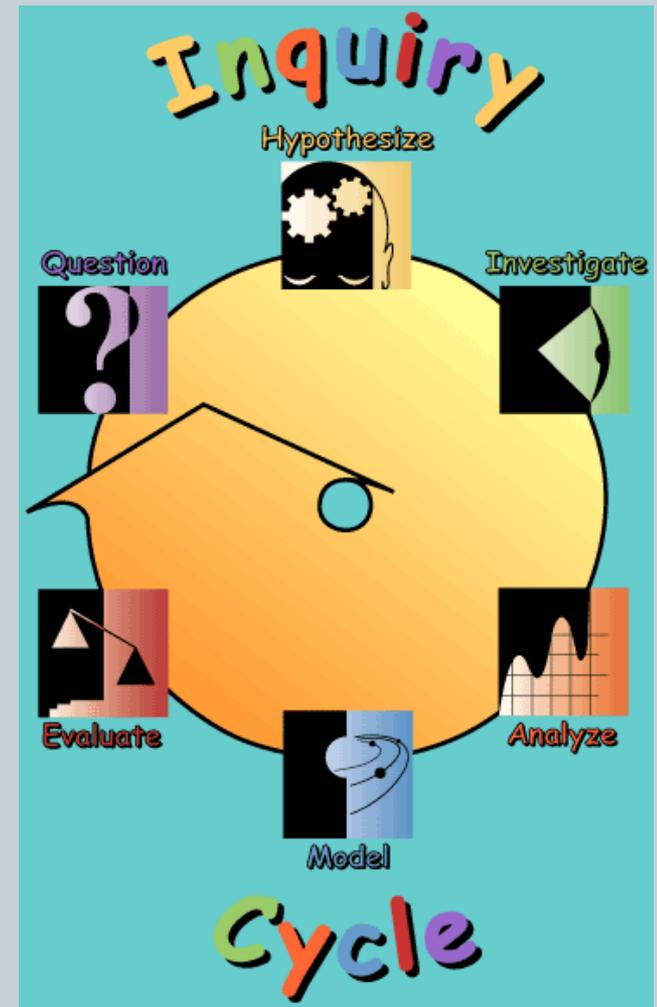
- **Question:** a new problem for the learner
- **Hypothesis:** Learner proposes a solution or a way to understand the problem better
- **Investigate:** Learner figures a way to try out the hypothesis (often an experiment)



# Metacognition

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- **Analyze:** understand the results of the investigation.
- **Model:** Construct a model or principle for what's going on.
- **Evaluate:** Evaluate the model, the hypothesis, everything that came before



# Scaffolding

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- Creating a “scaffold” to build the structure of learning on
  - Scaffold is gradually removed
  - Teacher -> teacher + learner -> learner
  
- Helps expand the ZPD gradually

# Scaffolding

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- **Scaffolding for young children (from NRC reading)**
  - Interesting the child in the task
  - Reducing the number of steps or otherwise simplifying task
  - Motivating and maintaining the pursuit of the goal
  - Marking critical features of discrepancies
  - Controlling frustration and risk
  - Demonstrating an idealized version

# Scaffolding

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# Summary

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- Piaget and Vygotsky led to studies of child learning
- Privileged domains
- Transfer and ZPD
- Metacognition
- Strategies
- Scaffolding

# Discussion Questions

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- All people learn - not many are Berkeley-graduate-student-level formal learners.
  - Why are we Berkeley grad students good learners? What subjects are easy to learn and why?
  - How should human learning influence the design of non-educational software?
- Pick a “concept” that many of you share (e.g. understanding code compilation or proving NP-completeness)
  - List some important steps that occur during microgenesis (understanding the concept)
  - Give the time frame for those steps