Toward a Mathematical Model of Learning

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Learning with Understanding or Adaptive Expertise

Learning that leads to

"... the ability to apply facts, concepts and skills in new situations, where they are appropriate."
Howard Gardner

Adaptive Expertise

To develop competence in an area of inquiry, students must

a. have a deep foundation of factual knowledge;

b. understand facts and ideas in a context of a conceptual framework; and

c. organize knowledge in ways that facilitate retrieval and application.

National Research Council Report (2000).
How people learn: Brain, mind, experience, and school.
http://www.nap.edu/openbook.php?isbn=0309070368

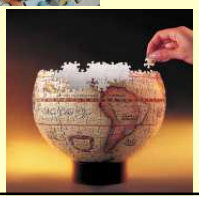
Learning Paradigms	Metaphor	Role of the Learner	Level of Understanding	Key Words
Behaviorism	Empty Vessel *Tabula Rasa*	Passive	Minimal	Stimulus-response Classical conditioning, Operant conditioning
Cognitivism	Mind as a Black Box Computer	Process Information Form Schemata (Learning Context)	Localized	Schemata Information Processing Symbol Manipulation, Information Mapping, Mental Models
Constructivism	Thinking About One's Thinking Metacognition	Learning as an Active Constructive Process New Knowledge Linked to Old	Focus on Understanding Knowledge	Learning Experience Active Dialog Problem based learning Anchored instruction Cognitive apprenticeship Inquiry/Discovery Learning.
Humanism	Metacognitive Mind Humanist Values	Personal Action Fulfilling One's Potential	Understanding Both Knowledge and Behavior	Self-Actualization Teacher as Facilitator Cognition and Affect Lifelong Learning

A Metaphor for Learning

Two Parts of Learning with Understanding

Learning

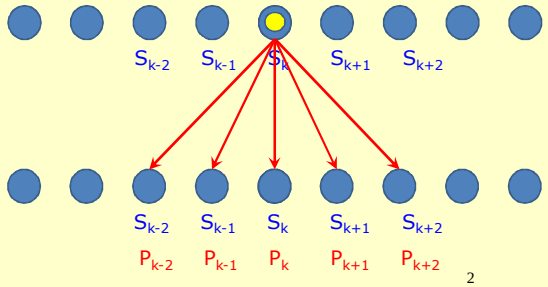
Understanding



Model for Learning

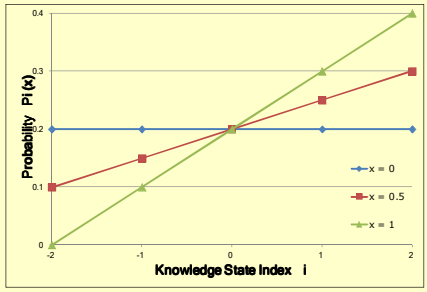
- constructivist paradigm
- over a long period (a course)
- no specific teaching or learning strategy
  many strategies used

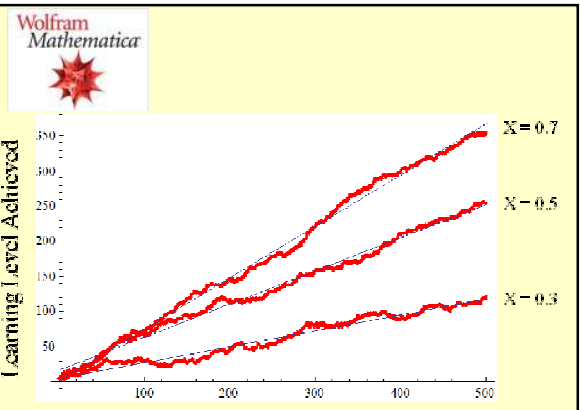
Knowledge is Represented by a Sequence of States



$$\sum_{k=-2}^{2} P_k = 1$$

A Simple Example $P_i(x) = \frac{i}{10}x + \frac{1}{5}$



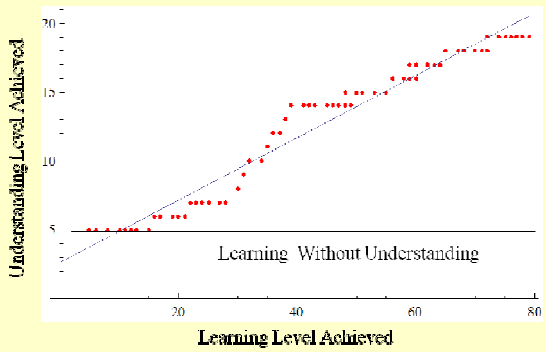


Knowledge Plus Understanding …

$$UP(x, x_0) = \begin{cases} 1 \text{ if } x \le x_0 \\ 0 \text{ if } x > x_0 \end{cases}$$

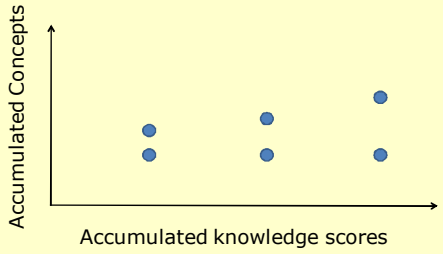
Learning Probability {0, 0.1, 0.3, 0.4, 0.2}

Understanding x_0 = 1/8



How to use these ideas:

Each test includes –
- knowledge questions
- concept questions
- non- discipline questions



How to determine "Learning Skill"

1) Factual test with non discipline questions
2) Open ended task with a time limit
3) Draw a map of your knowledge network

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