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Research-Based Generalizations: Student Learning with "Traditional" Teaching

1. Facility in solving standard quantitative problems is not an adequate criterion for functional understanding.
2. Connections among concepts, formal representations, and the real world are often lacking after traditional instruction.
3. Certain conceptual difficulties are not overcome by traditional instruction. (Advanced study may not increase understanding of basic concepts.)
4. A coherent conceptual framework is not typically an outcome of traditional instruction.
5. Growth in reasoning ability often does not result from traditional instruction.
6. Teaching by telling is an ineffective mode of instruction for most students.

Lillian C. McDermott,
Am. J. Phys. 69 (11), 1127-1137 2001.

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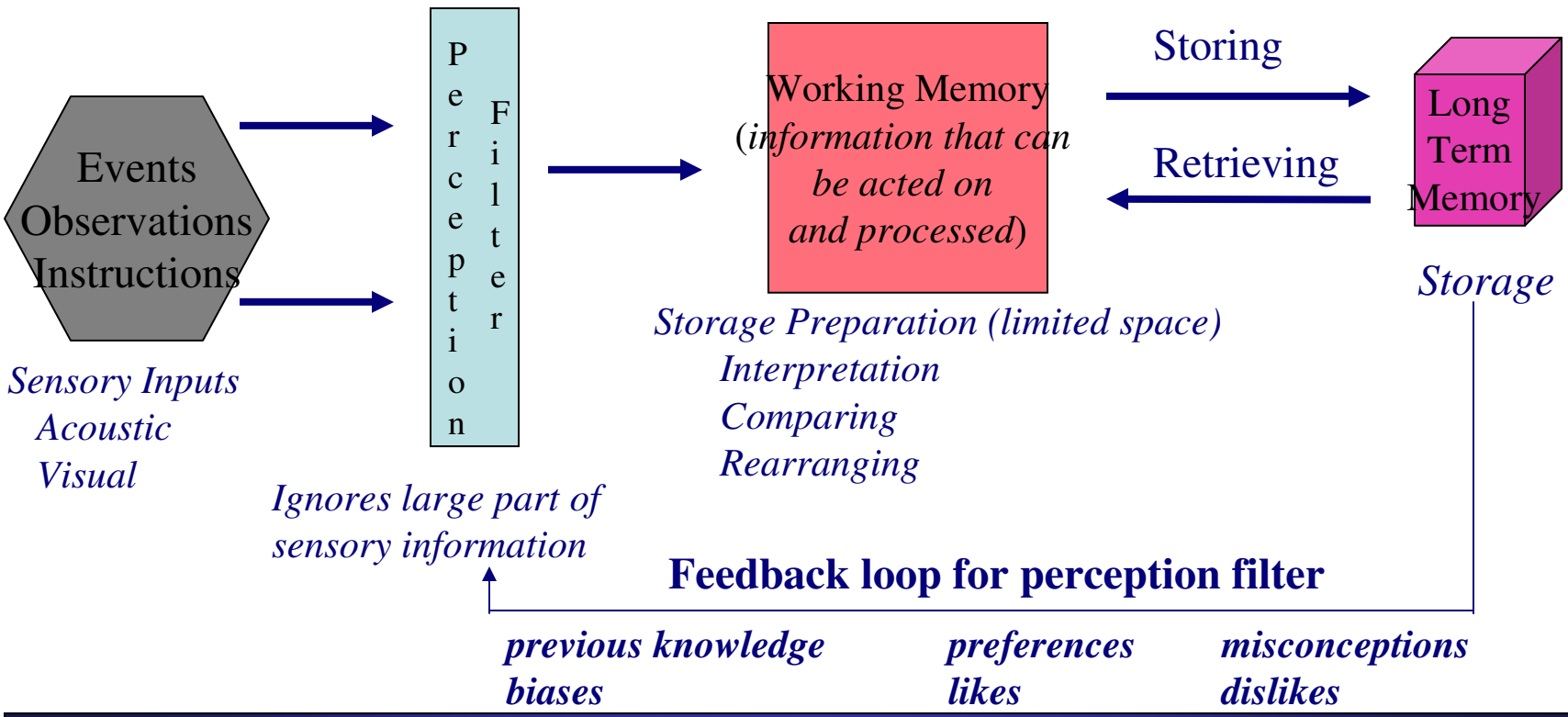
Information Processing Model



A. H. Johnstone, *J. Chem. Educ.* 1997, 74, 262.
Gazzaniga *et al. Cognitive Neuroscience*, 1998.

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Social Constructivism

1. Knowledge cannot be transferred "intact" to the learner, rather is [re]constructed in the mind of the learner based on experience. (J. Piaget)
2. ***The most important single factor influencing learning is what the learner already knows. (D. Ausubel)***
3. The acquisition and application of knowledge are mediated by social interactions. (L. Vygotsky)

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Ways to More Effectively Promote Student Learning

- Use *active* modes of teaching and learning
- Experiential learning that actively engages students' senses in the subject matter; for example:
  - Small group discussions and projects
  - In-class presentations and debates
  - Monitored experiential learning
  - Peer critiques
  - Field experiences
  - Developing simulations
  - Case/problem-based approaches

Learning Cycle (Karplus, Piaget)

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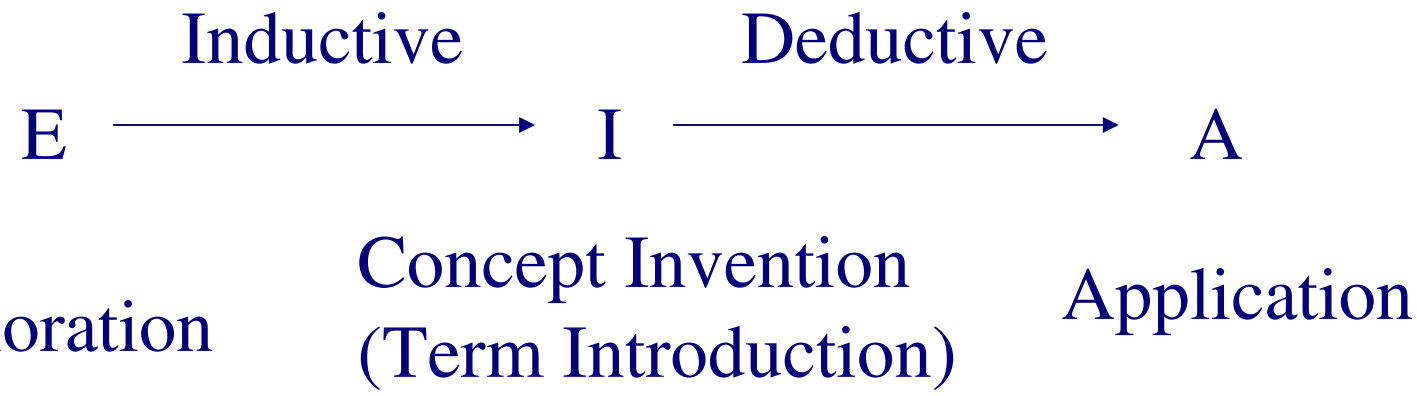

- Parallels the scientific method
- Ideas do not appear in your brain fully formed
- Being wrong is a stage on the way to being more right

Karplus and Thier, *A New Look at Elementary School Science,* Chicago:Rand McNally (1967).
Piaget, J. *J. Res. Sci. Teach.* 1964, 2, 176.

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Exploration

- Make observations
- Propose questions
- Test hypotheses
- Design experiments
- Collect and interpret data
- Analyze information and models
- Identify relationships and patterns

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Concept Invention

- Making sense of exploration
  - Direct learner to specific information
  - Lead learner to making appropriate connections and conclusions
  - Help learner construct desired concept(s)

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Application

- Reinforcing and extending new knowledge
  - Simple situations with familiar context
  - Transfer of new knowledge to unfamiliar context
  - Synthesis with other knowledge
  - Solving real-world problems

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Three Question Types

- Directed: examine and recall
  - examine model, information, resources, or prior knowledge
  - Have definite desired answer which is directly available from model, etc.
- Convergent: making connections and conclusions
  - Require analysis and synthesis (answers not directly available)
  - May have more than one pathway to a single desired answer
  - Promotes critical analysis of procedure/problem solutions
- Divergent: generalization and applicability
  - Open-ended and without unique answers
  - Promote discussion

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Dissecting a POGIL Activity

- Task 1: Examine questions of POGIL activity and identify as Explore, Concept Invention, or Application
- Task 2: Examine questions of POGIL activity and identify as “directed,” “convergent,” or “divergent”
- Whole group discusion:

  What is the relationship?

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Dissecting POGIL-like Activities

- Task: Review one of the provided activities, studying the overall organization.
  - What learning cycle is used (Karplus, 5E, 7E?)
  - Is there clear distinction between exploration, concept invention, and application stages?
  - How are questions scaffolded (directed→convergent→divergent, or a mix)?
- Small Group Discussion:

  What did you find?

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Online Resources

- www.pogil.org

  www.pogil.org/materials/high_school.php

  www.pogil.org/resources/pogil_ig.php
  - Teaching and authoring guides (includes learning theory!)
  - Listing of peer-reviewed and published resources
  - Workshop dates, location, and sign-up
- www.highschoolpogils.org/ **
  - MCEP and MISEP student contributions
  - Find and submit POGIL activities