How Do People Learn?

Jeff Froyd, Texas A&M University

"There is an incredible evolution of learning or education as almost the sole source of competitive advantage in an economy that has changed so much."

Howard Block, Managing Director

Banc of America Securities

An investment-bank and brokerage subsidiary of Bank of America.

Workshop Outline

- **Getting Started**
  - 5 minutes
- **Focusing Exercise**
  - 10 minutes
- **Model for Learning and Teaching**
  - 15 minutes
- **Expectations and Assessment**
  - ?? minutes
- **Streams of Learning Theory**
  - ?? minutes
- **Expectations and Learning Strategies**
  - ?? minutes

Part I
Getting Started

Jeff Froyd, Texas A&M University

P.K. Imbrie, Purdue University

Introduction: Team Formation

- **Self-Organize into groups of four people**
  - Try working with people from different institutions
  - Introduce yourselves (name, institution, etc..) within the group

Make a sheet of paper

+	Δ
Issue Bin Questions Comments Reflections	

Part II
Focusing Exercise

Jeff Froyd, Texas A&M University

Team Activity (5 minutes)

- **INDIVIDUALLY** – use 2 minutes to write, on a piece of paper, your description of learning, what it is, what it looks like, how you might recognize when it has occurred, etc.
- **AS A TEAM** – use 3 minutes to discuss each member's descriptions. If you have additional time, develop a consensus description of learning.

Workshop Sharing (5 minutes)

- Working with problems, changing/developing previous knowledge by learner, the group couldn't agree on what it looked like
- Learning is knowledge and understanding which can be used for problem solving in a specific area.
- Learning is obtaining knowledge, changing your perspective, see that learning has occurred from interactions with others, gives you new possibilities for action
- **Learning is about receiving new info/knowledge and make a change in yourself so that you restructure what you know so that you behave in a new way**

Update your +/Δ sheet

Part III
Model for Learning and Teaching

Jeff Froyd, Texas A&M University

Four Fundamental Questions

- What do I want people to learn?
- Where are learners starting from?
- How do people learn?
- How might I facilitate learning?

Pedagogical Approaches

- Active Learning
- Cooperative Learning
- Problem-Based Learning
- Project-Based Learning
- Discovery Learning
- Inquiry-Based Learning
- Distance Learning

Possible Confusion

"A common misconception regarding 'constructivist' theories of knowing (that existing knowledge is used to build new knowledge) is that teachers should never tell students anything directly but, instead, should always allow them to construct knowledge for themselves. This perspective confuses a theory of pedagogy (teaching) with a theory of knowing. Constructivists assume that knowledge is constructed from previous knowledge, irrespective of how one is taught -- even listening to a lecture involves active attempts to construct new knowledge… Nevertheless, there are times, usually after people have first grappled with issues on their own, that 'teaching by telling' can work extremely well."

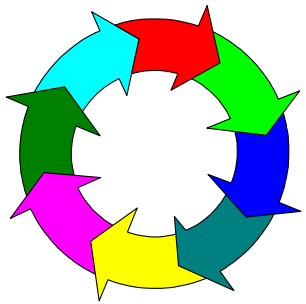
***How People Learn*, Bransford, John D. et. al. 1999**

Expectations and Assessment

What do you want people to learn?

Learning Theories

How do people learn?



Pedagogical Theories

How do you facilitate learning?

Current Reality

What are learners starting from?

Expectations and Assessment

What do you want people to learn?

- Course syllabi
- Learning objectives
- Taxonomies, e.g., Bloom's Taxonomy, …
- Competency matrices
- Rubrics

Question:
Where are participants starting?

- Answer #1: **Course syllabi**
- Answer #2: **Learning objectives**
- Answer #3: **Taxonomies of learning**
- Answer #4: **Competency Matrices**
- Answer #5: **Rubrics**

Individual Exercise

Rate your understanding of each of the preceding concepts about establishing your expectations for students.

0 – No knowledge

1 – Aware of term

2 – Know enough to want to know more

3 – Know enough that topic could be skipped in the workshop

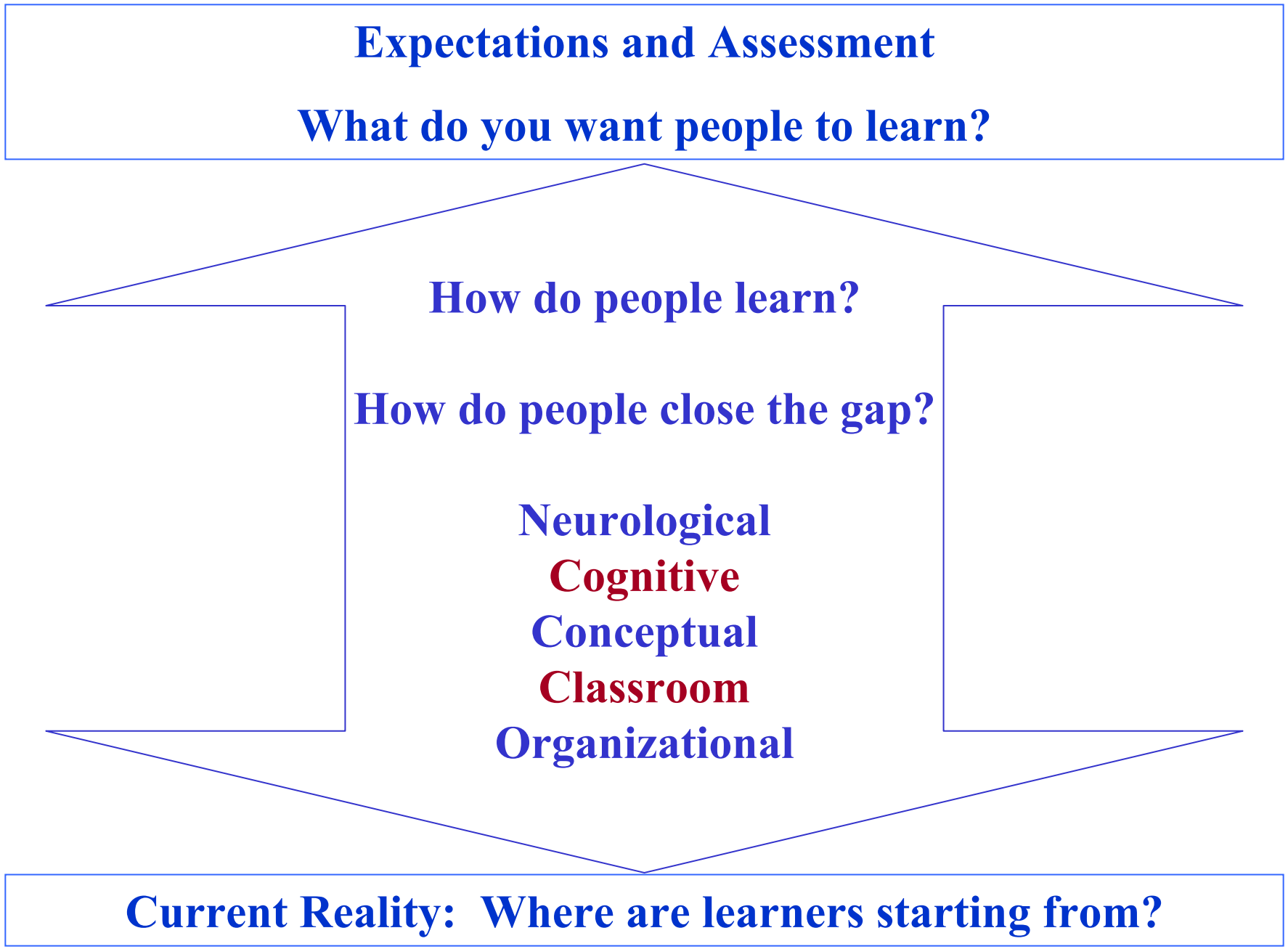
Expectations and Assessment

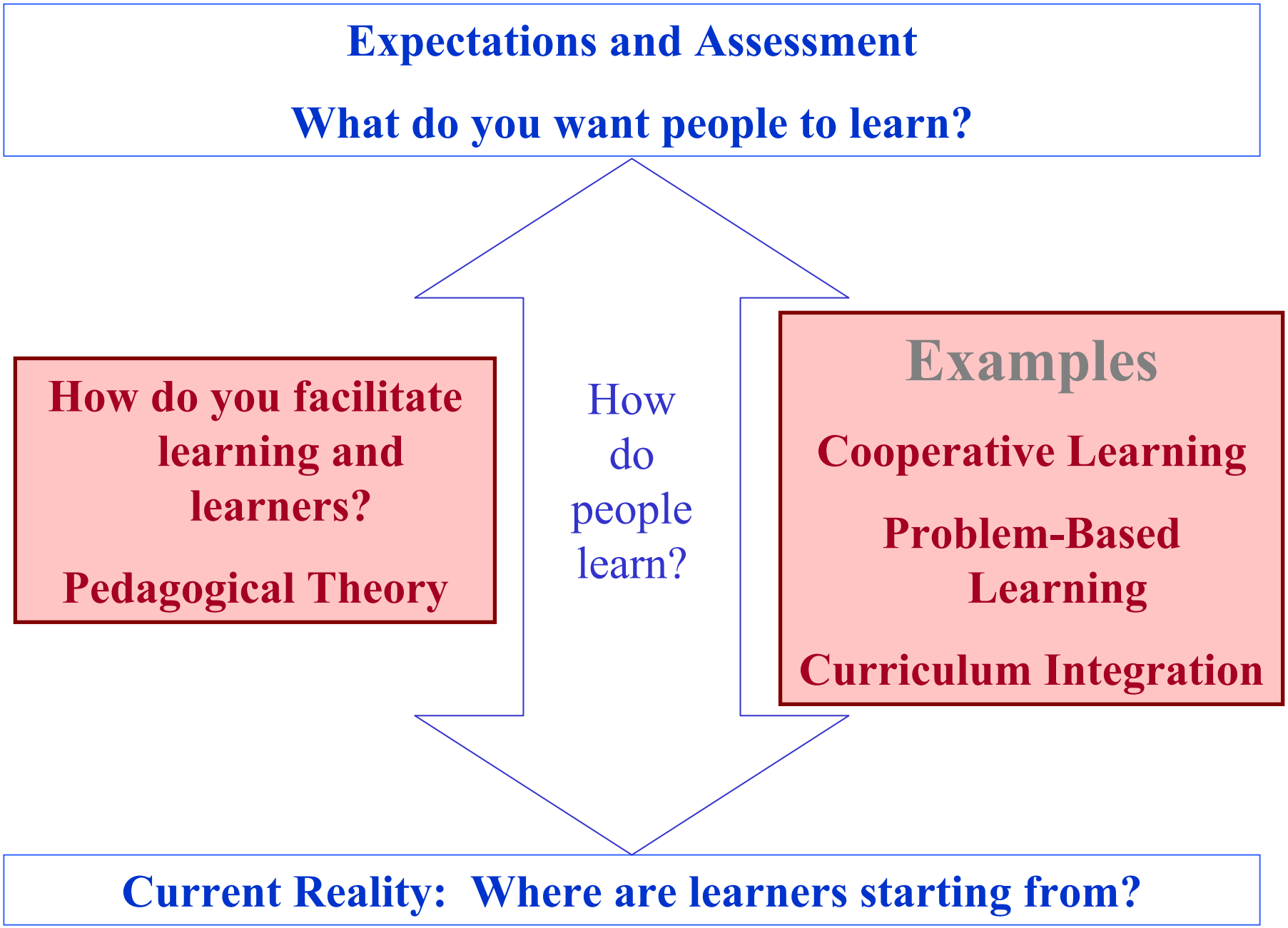
What do you want people to learn?

Current Reality

Where are learners starting from?

- Existing knowledge, strategies, beliefs, etc.
  - Experience with past students
- Data about entering students
- Self-assessment
- Pre-tests (placement tests, SPQ, LASSI)


Expectations and Assessment
What do you want people to learn?
How do people learn?
How do people close the gap?
Neurological
Cognitive
Conceptual
Classroom
Organizational
Current Reality: Where are learners starting from?


Expectations and Assessment
What do you want people to learn?
How do you facilitate learning and learners?
Pedagogical Theory
How do people learn?
Examples
Cooperative Learning
Problem-Based Learning
Curriculum Integration
Current Reality: Where are learners starting from?

Four Questions

- **What do I want people to learn?**
  - Expectations, judgment
- **Where are learners starting from?**
  - Data, experience
- **How do people learn?**
  - Learning processes, learning theory
  - Research: neurology, psychology, cognitive science, artificial intelligence, physics education
- **How might I facilitate learning?**
  - Teaching processes, pedagogical theory

Assessment Tetrahedron

- **What do I want people to learn?**
  - Expectations, judgment
- **How do people learn?**
  - Learning processes, learning theory
  - Research: neurology, psychology, cognitive science, artificial intelligence, physics education
- **How might I acquire data about learning?**
  - Measurement theory
- **How might I interpret data about learning?**
  - Statistics, modeling

Reflection Model for Learning and Teaching

Team Exercise

THINK-PAIR-SHARE

Identify two insights that you have gained from the four-question model for learning and teaching.

Identify two questions for which you would like answers.

Reflection
Model for Learning and Teaching

- Difference among students; they are not alike in their starting points
- Discrimination between the learning and teaching methods is essential and not obvious
- What is it that we expect?
- Difference between pedagogy and learning; should talk about learning or stick to talking about pedagogy
- How to cope with differences among students?
- Is it possible to organize learning to take differences among students seriously without extra resources?
- What does one know about learning theory and processes and what is the knowledge basis?
- SPC – Is it fruitful? Is it relevant?
- How do you decide your expectations in a changing world?
- Don't we have departments for learning that are integrated?

Update your +/Δ sheet

Part IV
Expectations and Assessment

Jeff Froyd, Texas A&M University

Question:
What do I want people to learn?

- **Answer #1: Course syllabi**
- **Answer #2: Learning objectives**
- **Answer #3: Taxonomies of learning**
- **Answer #4: Competency matrices**
- **Answer #5: Rubrics**

Expectations
Course Syllabus

- A **course syllabus** lists the topics that students are expected to learn.

- A **topic** helps students to name a set of ideas to be mastered, but does not help them picture what they are expected to do with the set of ideas.

Expectations
Learning Objectives

- **A learning objective describes expected student behavior under specified conditions.**
  - DO: Focus on expected behavior: solve, apply, etc.
  - DO: Describe conditions under which the expected behavior is to occur.
  - DON'T: Use words such as understand, know, appreciate, value

A **challenge** with learning objectives is that if you list all the learning objectives for your course, you have a **large** list.

Expectations
What is Bloom's Taxonomy?

A **taxonomy** is a classification scheme. Organizing a large list of items into separate categories is a standard response to complexity caused by a large number of items.

- **Six different levels of learning for any topic**
- **Each level requires mastery of lower levels (theory of learning)**

Expectations
What is Bloom's Taxonomy?

- **Remembering**
- **Understanding**
- **Application**
- **Analysis**
- **Evaluating**
- **Creating**

A Taxonomy for Learning, Teaching, and Assessment, Lorin W. Anderson and David Krathwohl, New York: Longman, New York

Expectations
What is Bloom's Taxonomy?

- **Remembering**
  - The ability to learn facts and to remember or recall previously learned materials, ideas or principles.
- **Understanding**
  - The ability to explain ideas or concepts?
- **Application**
  - The ability to use learned material in new and concrete situations.
- **Analysis**
  - The ability to break down material into parts and see relationships. This includes classifying, analyzing and distinguishing the parts.
- **Evaluating**
  - The ability to justify a decision or course of action?
- **Creating**
  - The ability to generate new products, ideas or ways of viewing things ?

Information Dump: What is Blosser's Taxonomy?

- Cognitive Memory
  - recall, recapitulate, clarify
- Convergent Thinking
  - explain, draw conclusions, solve problems
- Divergent Thinking
  - elaborate, synthesize, generate alternatives
- Evaluative Thinking
  - rate, judge, select from set of alternatives, prioritize

Expectations
What is a competency matrix?

	Remember	Understand	Apply	Analyze	Evaluate	Create
Topic 1						
Topic 2						
Topic 3						
Topic 4						

Expectations: What are rubrics?

- For a learning objective, the answer to the question of whether a student has mastered the material is either YES or NO.
- A rubric creates different levels of mastery and provides a description or criteria of satisfaction for each level.

Expectations: What are rubrics?

Table 1

Rubric for Evaluating Composition of Instructional Objectives (IO)

	Unacceptable Performance	Minimally Acceptable Performance	Acceptable Performance	Good Performance	Superior Performance
When given a topic, the learner is able to compose an IO.	Composes an IO that fails to specify all the elements of the definition.	Composes an IO with all the required elements	Composes IOs at the lowest levels of Bloom's taxonomy	Composes IOs at several different levels of Bloom's taxonomy including higher levels	Composes IOs at all six levels of Bloom's taxonomy

Expectations: What are rubrics?

Team Exercise

Pick a task related to teaching and build a rubric for it.

Group Exercise

Course syllabi / Learning objectives

Taxonomies of learning / Rubrics

For each of your classes, which of the above methods might you use when describing "What do I want people to learn?"

Group Discussion to generate answer

Group Reflections

- Tired of Bloom's taxonomy; difficult to use
- Rubrics could be a general way of putting learning into perspective; clarifies expectations of students at different levels; make your own priorities
- Rubrics may require a lot of work to prepare; students may have a difficult time to understand

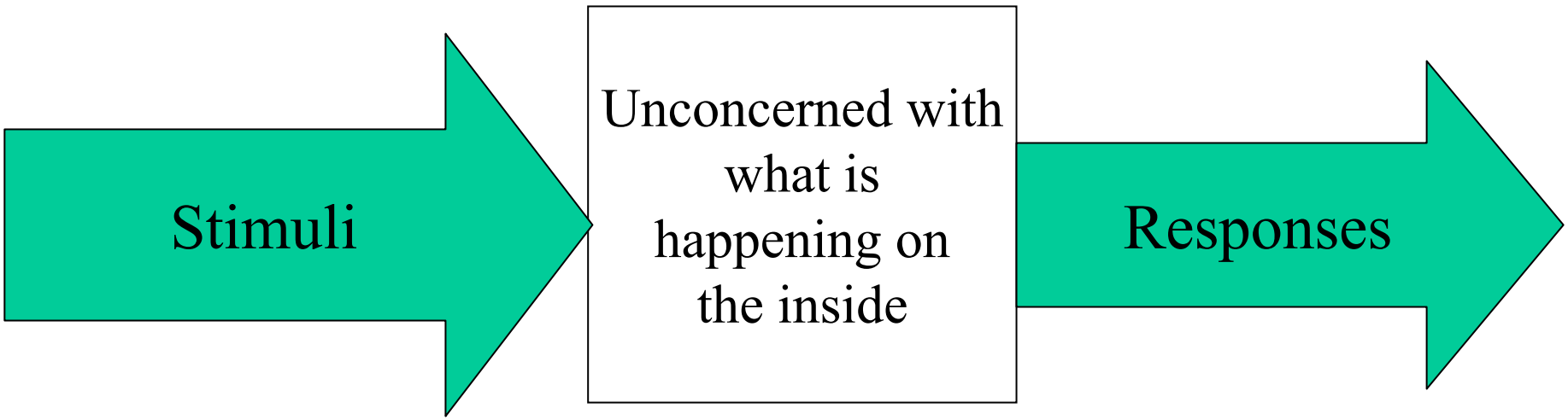
Part V
Streams of Learning Theory

Jeff Froyd, Texas A&M University

Evolution of Streams of Learning

- **Stream 1: Behaviorist Stream**
- **Stream 2: Cognitive (Information Processing) Stream**
- **Stream 3: Metacognitive Stream**
- **Stream 4: Learner-Centered Stream**

Behaviorist



Behaviorist

- **Learning as conditioning**
- **Classical conditioning**
  - Pavlov's dogs
- **Operant conditioning**
  - Training dogs with a reward, eventually the reward is no longer needed

Behaviorist

- **Learning as associations among stimuli and responses**
- **Instructional implications**
  - **Specify outcomes in clear, observable terms known as instructional objectives**
  - **Divide the target behaviors into small, easy-to-achieve steps and present in a logical sequence**
  - **Use mastery as the criterion for progress**

Behaviorist

Individual-Team-Share

- What elements of the behaviorist model do you recognize in your learning? Your teaching?
  - ??
- If a teacher adopted a behaviorist model of learning, what might be the roles of the teacher?
  - ??
- Select a change you might wish to make
  - ??
- **Question for reflection**: Will instruction based on a behaviorist stream develop the type of graduates that we envision?
  - ??

Behaviorist Reflections

- We are very depending on positive feedback from students and colleagues.
- We're brought up with it.
- We control the situation; we know what will happen and how it would be evaluated. It is safe and boring if you do it.
- Roles: Pointing out goals/aims/level/directions; give positive and negative feedback;training model; make students happy in conflict with what might be best for them.
- Changes: System of testing and rewarding does not promote reflection and metacognition

Update your +/Δ sheet

Why might a behaviorist model be inadequate?

- **"Is it going to be on the test?"**
  - Learning to the test
  - Teaching to the test
  - Performance focus instead of mastery focus
- **"Didn't you learn this in the prerequisite class?"**
  - Remembering words: fMRI studies
  - Linkages: remembering people's names
  - Transfer/application of knowledge
  - Qualitative study at Berkeley
  - Gender differences in approaches to problem solving
- **"Can you envision a behaviorist learning environment that promotes higher levels of learning?"**

Recalling Words/Images

- **fMRI studies can show what part(s) of the brain are active during a particular task.**
- **Place subjects in fMRI tunnel and show them a list of words (images).**
- **Can you predict from the fMRI scan taken during the presentation of a word (image) whether a subject will recall the word (image)**
- **Yes! Activity in two regions is important.**
  - One region is in the inner part of the temporal lobe: the parahippocampal gyrus in the left (right) cerebral hemisphere.
  - The other region is in the lower left (right) part of the frontal lobes, where apparently links are being made to existing information.

Recalling Names

- Have you ever been talking to someone and said, "Someone was telling me about X and her name is ……. I can't remember."
- However, you can remember what the person looked like, where she lives, her occupation, etc.
- If you imagine a giant concept map within the brain, it appears that names (or other proper names) are often weakly connected to other concepts as opposed to common nouns.
- Without intention, instruction on a new concept may create a map in which the concept is weakly connected to other ideas.

Challenge of Transfer

Researches posed this problem to people.

"Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the health tissue?"

Challenge of Transfer

Consider the following story

"A small country was ruled from a strong fortress by a dictator. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads led to the fortress through the countryside. A rebel general vowed to capture the fortress. The general knew that an attack by his entire army would capture the fortress. He gathered his army at the head of one of the roads, ready to launch a full-scale direct attack. However, the general then learned that the dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator need to move his troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road, but it would also destroy many neighboring villages. It therefore seemed impossible to capture the fortress. However, the general devised a simple plan. He divided his army into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal and each group marched down a different road. Each group continued down it road to the fortress at the same time. In this way, the general captured the fortress and overthrew the dictator."

Challenge of Transfer

- After the subjects read and summarized this story, they were asked to solve the tumor problem under the guise of a separate experiment.
- Given the clear analogy, you might think that performance would be near ceiling. Surprisingly, only 30% of the subjects offered a convergence solution.
- Moreover, when these same subjects were given the suggestion that they should use the General story, 80% provided a convergence solution.
- This finding demonstrates that half the subjects could apply the General story to the tumor problem when they were instructed to but did not do so on their own.

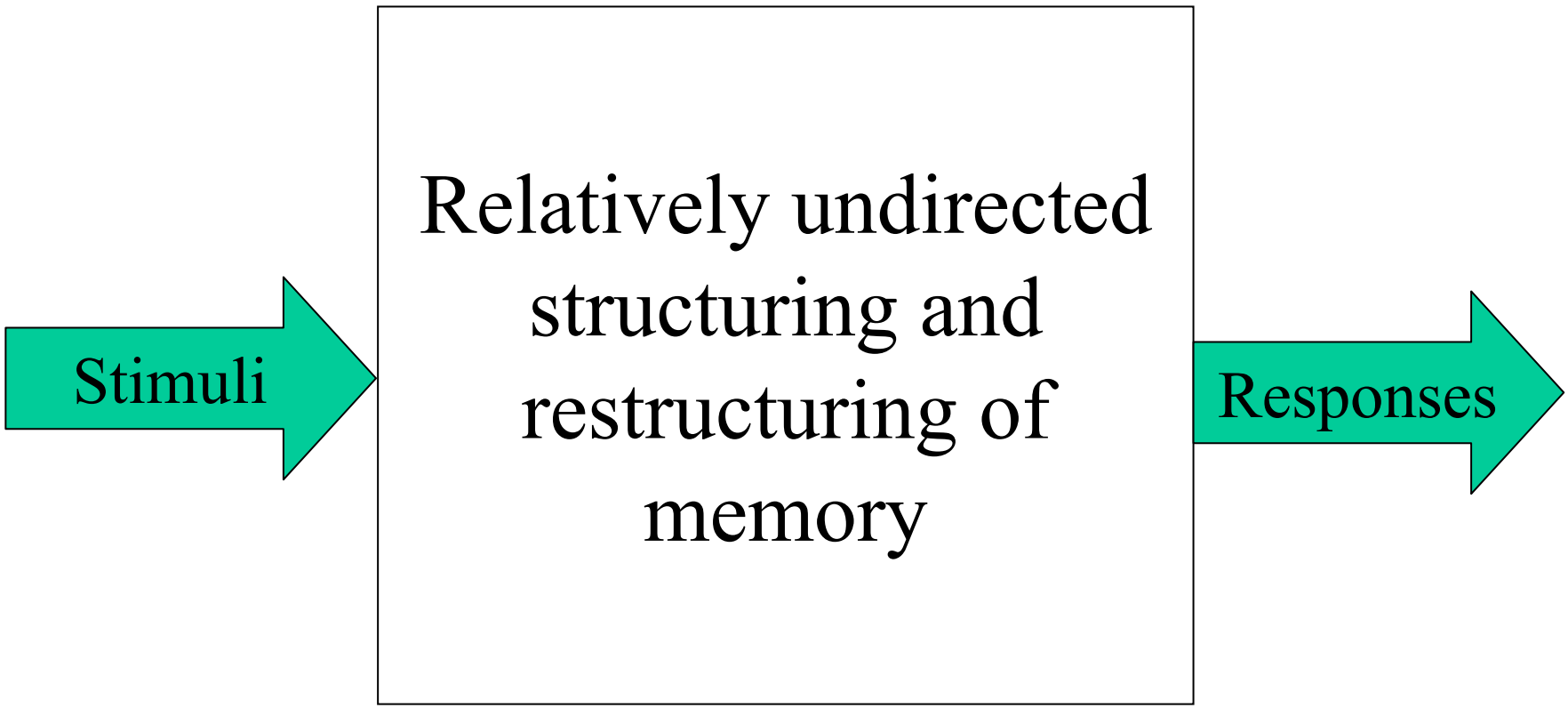
Student Perspective

- Researchers at the University of California Berkeley interviewed about 70 mechanical engineering students about their learning experiences in college.
- Although the researchers were aware of various integrated curricula that had been implemented across the country, they were interested in the student perspective of integration, as well as the pedagogical perspective.
- Data from the interviews tended to support the value of linking concepts. For example, “Of the 70 students interviewed, 60% commented on the benefit of linking concepts across disciplines.”

Gender Differences

- Rosser and Sandler both report a difference between how men and women approach problems.
- **Men tend to handle problems with a single correct or concrete answer comfortably**
- Women are better able to deal with complex problems and problems that are ambiguous.
- **Rosser asserts that many of the first year courses are more directed to single correct or concrete answers, which favor the learning style of men. This is one of the reasons, she believes, that women with high GPAs may leave the major in the first year.**

Cognitive, Information Processing



Cognitive, Information Processing

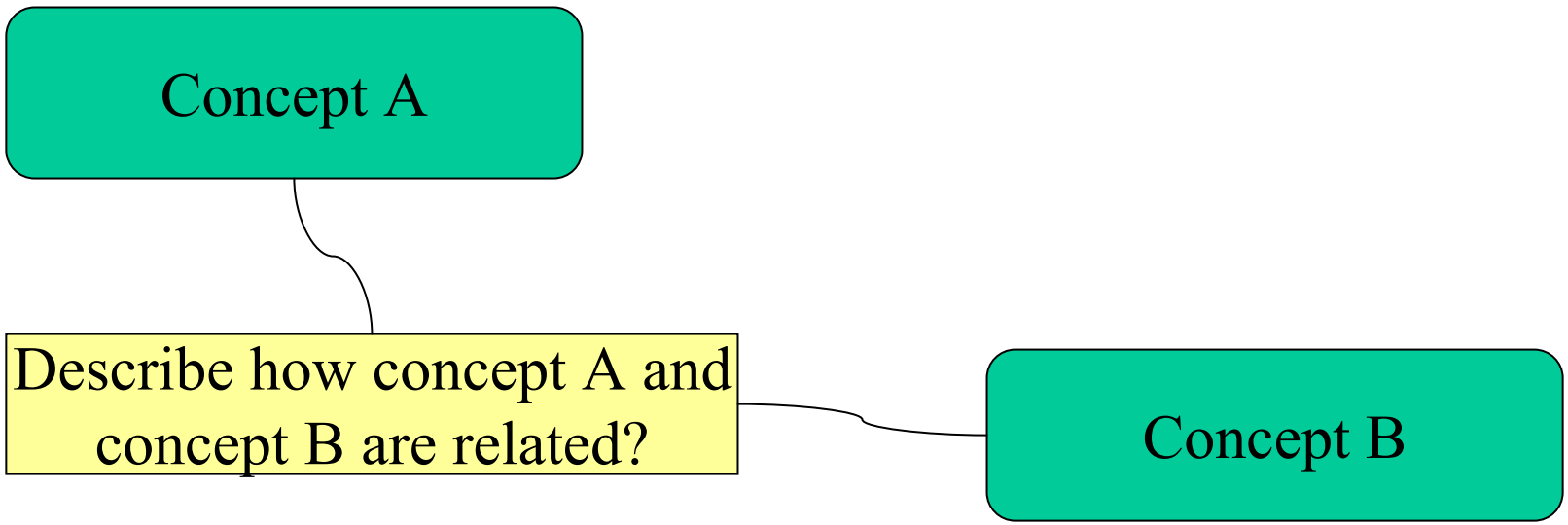
- **Learning as information processing**
- **Elements**
  - Memory: short-term and long-term
  - Processing
  - Executive
- **Questions**
  - How is the information being organized and represented?
  - How does the learner encode new information?

Cognitive, Information Processing

- **Learning as structuring and restructuring memory**
- **Instructional implications**
  - **Direct student's attention to key points**
  - **Emphasize how material is organized**
  - **Make information more meaningful to learners**
  - **Encourage active checking of understanding**
  - **Recognize the limitations of working memory**
  - **Understand how learners might be representing prior and new information**

Concept Map

- A concept map is a set of nodes that represent concepts connected by a labeled links that describe a link between concepts.



Team Exercise
Building a Concept Map

- Start with a subset of the concepts on the following page and construct a concept map that shows the concepts you have selected and how they are related.
- Exchange concept maps and share insights

- Feedback
- Derivative
- Finite Element Analysis
- Integral
- Linear Momentum
- Angular Momentum
- Energy
- Interest
- Mass
- Ideal Gas Law
- Fick's First Law
- Fick's Second Law
- Vectors: Dot Product
- Vectors: Cross Product
- Ordinary Differential Equations
- Determinants
- Return on Investment
- Kirchoff's Voltage Law
- Second Law of Thermodynamics
- Kirchoff's Current Law
- Modeling
- Problem-Solving
- Force
- Ohm's Law
- Resistance
- Complex Numbers
- Logarithmic Function
- Electric Flux
- Decision Theory
- Divergence
- Indirect Cost
- Capacitance
- Bending Moment
- First Law of Thermodynamics Entropy
- Heat
- Electric Field
- Magnetic Field
- Partial Differential Equations
- Phasors
- Brainstorming
- Exponential Function
- Conductivity
- Chemical Kinetics
- Specific Heat
- Elasticity
- Malleability
- Plasticity
- Resiliency
- Permittivity
- Current
- Electric Potential
- Curl
- Presentation Skills
- Democracy
- Profit
- Density
- Molecule
- Phase
- Shear
- Rheology
- Frequency Response
- Eigenvalue, Eigenvector
- Sinusoidal Functions
- Work
- Displacement
- Velocity
- Acceleration
- Resistivity
- Leadership
- Hess' Law
- Zeroth Law of Thermodynamics
- Electric Potential
- Magnetic Flux
- Design
- Maxwell's Equations
- Power
- Ductility
- Spring Constant
- Stress
- Strain
- Partial Derivative
- Permeability
- Charge
- Magnetic Potential
- Gradient

References: Concept Mapping

- Turns, Jennifer, Cynthia J. Atman, and Robin Adams, "Concept Maps for Engineering Education: A Cognitively Motivated Tool Supporting Varied Assessment Functions," *IEEE Transactions on Education Special Issue on Assessment*, May 2000.

Cognitive, Information Processing

Team-Share

- What elements of the cognitive model do you recognize in your learning?
  - ??
- If a teacher adopted a cognitive model of learning, what might be the roles of the teacher?
  - ??
- Select a change you might make
  - ??
- **Question for reflection**: Will instruction based on a cognitive stream develop the type of graduates that we envision?
  - ??

Reflections on the Cognitive Model

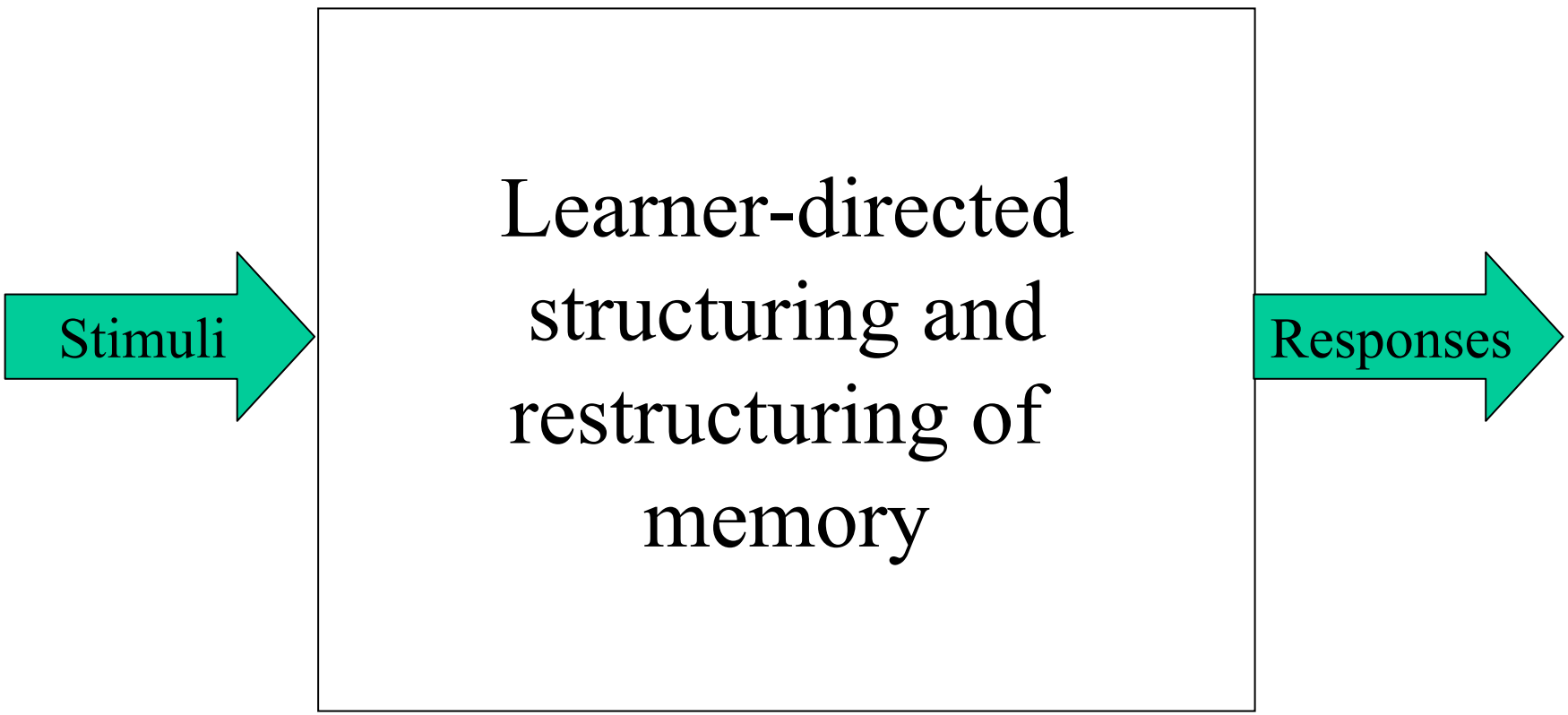
- Breaking down problems into recognizable units
- I like general structures that can be taken from one area to another: picture of mechanics physics related to picture of electric physics
- Creating graphical relations can promote understanding
- Too much abstraction makes it difficult for me
- Students might question the relevance of understanding the relationships
- Requires experience in building and using abstractions
- Roles: facilitator to get students to interact; supply relevant problems; listening and asking questions and waiting for answers; work in advance to develop a better understanding of the structuring the material;
- Changes: possible include concepts in textbook; checking structuring of the material; ask different questions in class, e.g., can you see relationships instead of computing a number; draw a map of relationships; careful about excluding less important material

Update your +/Δ sheet

Why might a cognitive model be inadequate?

- **"Is it going to be on the test?"**
  - Performance focus instead of mastery focus
  - Developing self-regulation of motivation
- **"Can you envision a cognitive learning environment that promotes higher levels of learning?"**
- **"Can you envision a cognitive learning environment that promotes learning to apply the engineering design process?"**

Metacognitive



Metacognitive

- **Learning as learner-directed structuring of memory; reflective learner**
- **Elements**
  - Memory: short-term and long-term
  - Processing
  - Executive
  - Metacognitive processor
- **Questions**
  - What learning strategies is the learner currently employing?
  - How does the learner adopt/adapt new strategies?
  - What environments support adoption of new strategies?

Metacognitive

- **Learner thinks about thinking, meta-cognition.**
- **Instructional implications**
  - **Model thinking processes**
  - **Promote reflection, e.g., journals, scripts of problem solving processes (Cowan), cooperative activities, after-action reviews**
  - **Explicitly teach learning strategies in the context of an engineering course**

Intelligent Novices

- Understanding vs. memorizing, appropriate mental strategies
- Difficult vs. easy text, appropriate reading strategies
- Solve problems and examples from a text in random order
- Recognizing poor understanding, and willingness to solicit expert help
- Recognizing when expert explanations were making a difference with immediate learning problem

Brown, A.L., et. al. (1983) "Learning, remembering, and understanding" in P.H. Mussen, ed., *Handbook of Child Psychology*, volume 3: *Cognitive Development*, Wiley

Cowan's Teaching Examples

- **Bridge design**
  - Design and build two different bridges and grade on the lower performance design
- **Problem-solving script**
  - Illustrate script for one type of problem, ask students to develop a script for another type of problem

Cowan, J. (1998) *On Becoming an Innovative University Teacher: Reflection in Action.* Buckingham: SRHE and Open University Press.

Evolution in Cognitive Learning Theory

- **Stage 1: Latin builds mental muscle**
  - Strong methods matter, any subject builds strong methods
- **Stage 2: General problem solving approaches**
  - Strong methods matter, but must present appropriate strong methods
- **Stage 3: Domain-specific instruction**
  - Weak methods matter, concentrate on domain-specific topics
- **Stage 4: Intelligent novices can be fostered**
  - Teaching strong strategies in context

Informed Strategy Instruction

- Include explicit descriptions of the general and/or metacognitive strategies
- Include explicit descriptions of **when** general and/or metacognitive strategies are useful
- Include explicit descriptions of **why** general and/or metacognitive strategies are useful.

Bruer, J. (1993) *Schools for Thought: A Science of Learning in the Classroom*. MIT Press, p. 75

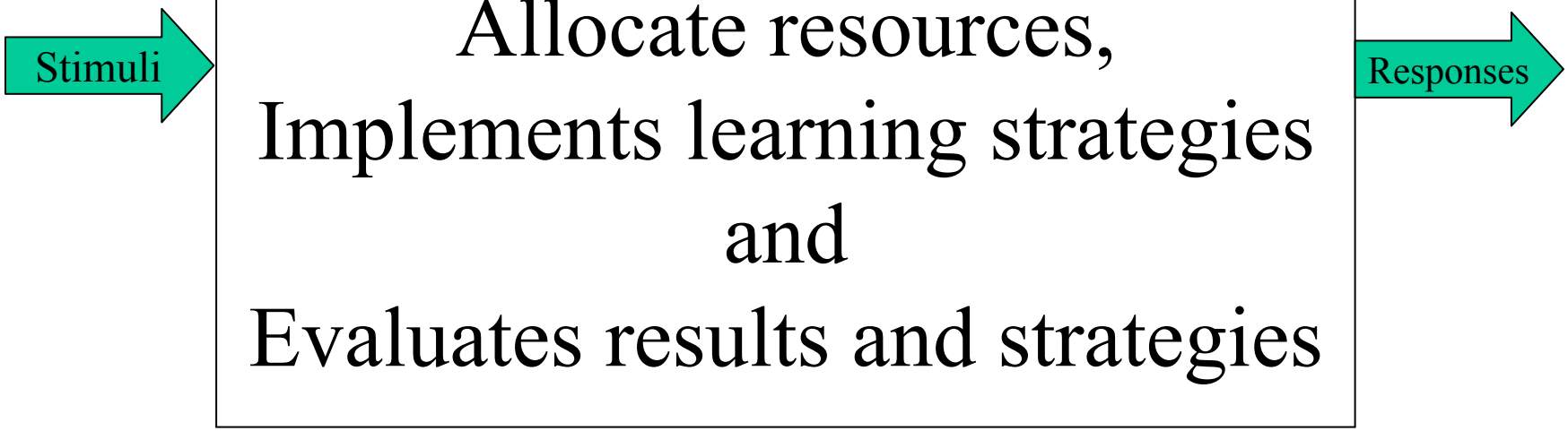
Metacognitive

Individual-Team-Share

- What elements of the metacognitive model do you recognize in your learning? Your teaching?
  - ??
- If a teacher adopted a metacognitive model of learning, what might be the roles of the teacher?
  - ??
- Select a change you might make in your teaching.
  - ??
- **Question for reflection**: Will instruction based on a metacognitive stream develop the type of graduates that we envision?
  - ??

Update your +/Δ sheet

Learner-Centered



Learner-Centered

- **Variations among learners**
  - Level of prior knowledge
  - Styles of cognitive processing, e.g., serial vs. holistic learners
  - Personality variables
  - Learning strategies
  - Beliefs about learning and thinking

Learner-Centered

- **Learner sets goals, marshals resources, strategically allocates resources, and self-evaluates results and strategies.**
- **Instructional implications**
  - **Encourage transition to self-directed learning**
  - **Encourage learning in groups**
  - **Promote authentic problem solving**

Learner-Centered

Individual-Team-Share

- What elements of the learner-centered model do you recognize in your learning? Your teaching?
  - ??
- If a teacher adopted a learner-centered model of learning, what might be the roles of the teacher?
  - ??
- Select a change you might make in your teaching.
  - ??
- **Question for reflection**: Will instruction based on a learner-centered stream develop the type of graduates that we envision?
  - ??

Update your +/Δ sheet

Part V
Interactions between Expectations and Learning Strategies

Jeff Froyd, Texas A&M University

Expectations

What is a competency matrix?

	Remember	Understand	Apply	Analyze	Evaluate	Create
Topic 1						
Topic 2						
Topic 3						
Topic 4						

How do people learn?
What are learning strategies?

- **Rehearsal**
  - Active repetition
  - Example: repeating vocabulary words
  - Example: identifying key ideas
- **Elaboration**
  - Building bridges between new material and existing material
  - Example: fMRI scan on remembering words
- **Organization**
  - Special case of elaboration strategies
  - Imposing an organizational framework on material under study
  - Example: concept map

Expectations and Learning

What is a strategy-level matrix?

	Remember	Understand	Apply	Analyze	Evaluate	Create
Rehearsal						
Elaboration						
Organization						

Expectations and Learning

What is a strategy-level matrix?

	Remember	Understand	Apply	Analyze	Evaluate	Create
Rehearsal						
Elaboration			Developing a problem solving scripts			
Organization						Find real-life problems; find problem that fits given subject; exchange their solutions with another critical

Team Exercise

Fill in portions of the matrix showing examples of strategies that students might adopt that are appropriate for a given level of learning.

Update your +/Δ sheet

References

- Svinicki, M. (1999) New Directions in Learning and Motivation in M. Svinicki (ed.), *Teaching and Learning on the Edge of the Millennium: Building on What We Have Learned*, New Directions for Teaching and Learning, volume 80, Winter, Jossey-Bass Publishers
- Reiner, Slotta, Chi, Resnick (2000) Naive Physics Reasoning: A Commitment to Substance-Based Conceptions, *Cognition and Instruction*, 18(1), 2000, 1-34
- Bruer, John T. (1993) *Schools for Thought: A Science of Learning in the Classroom*. MIT Press
- Squire, Larry and Eric Kandel, *Memory: From Mind to Molecules*, New York, Scientific American Library, 1999
- Theall, M. *Motivation from Within: Encouraging Faculty and Students to Excel*, New Directions for Teaching and Learning, no. 78, San Francisco: Jossey-Bass, 1999
- Cowan, J. (1998) *On Becoming an Innovative University Teacher: Reflection in Action*. Buckingham: SRHE and Open University Press.

Workshop Tenets

- **Each learner needs learning goals**
- **Each learner relates incoming information to his/her existing cognitive network**
- **Sharing and listening to the insights of others helps improve your understanding of workshop content**
- **Effective workshops are partnerships between facilitators and participants.**
  - Effective workshops do not occur when participants expect the facilitators to do all the cognitive work
  - Effective workshops do not occur when facilitators expect that participants will be able to “just make sense” out of a large set of informative slides
- **Each participant brings many mental models to learning and change experiences.**

Reflection
How might I facilitate learning?

Team Exercise

Behavioral Models (Teams: 1, 5, 9, …)

How might you facilitate learning?

Information Processing Models (Teams: 2, 6, 10, …)

How might you facilitate learning?

Metacognitive Models (Teams: 3, 7, 11, …)

How might you facilitate learning?

Learner-Centered Models (Teams: 4, 8, 12, …)

How might you facilitate learning?

Report out to group