

# Design and Implementation of Pedagogies of Engagement: Cooperative Learning and Challenge-Based Learning

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Effective Teaching: Moving to a Student-Centered Paradigm with  
the Adoption of Criterion-Referenced Assessment

Hong Kong Baptist University  
Centre for Holistic Teaching and Learning

28 October 2011

## Session Layout

- Welcome & Overview
- Course Design Foundations
  - Understanding by Design (UdB)
    - Integrated Course Design (CAP Model)
      - Content – Assessment – Pedagogy
  - How People Learn (HPL)
    - How Learning Works (Ambrose, et al.)
- Pedagogies of Engagement – Cooperative Learning and Challenge Based Learning
  - Informal – Bookends on a Class Session
  - Formal Cooperative Learning
- Design and Implementation

## Workshop Objectives

- Participants will be able to
  - Explain rationale for Pedagogies of Engagement, especially Cooperative Learning & Challenge Based Learning
  - Describe key features of Cooperative Learning
  - Apply cooperative learning to classroom practice
  - Describe key features of the Understanding by Design and How People Learn
  - Identify connections between cooperative learning and desired outcomes of courses and programs

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It could well be that faculty members of the twenty-first century college or university will find it necessary to set aside their roles as teachers and instead become **designers** of learning experiences, processes, and environments.

James Duderstadt, 1999 [Nuclear Engineering Professor; Dean, Provost and President of the University of Michigan]



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# Design Foundations



## Science of Instruction (UbD)

## Science of Learning (HPL)

Yes

No

No

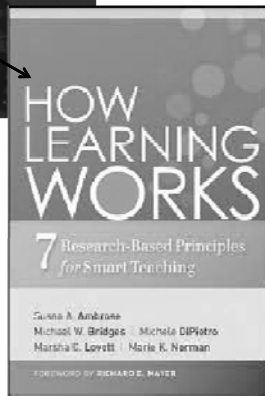
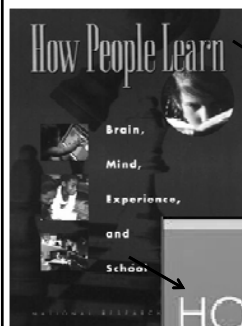
Yes

Good Theory/  
Poor Practice

Good Theory &  
Good Practice

Good Practice/  
Poor Theory

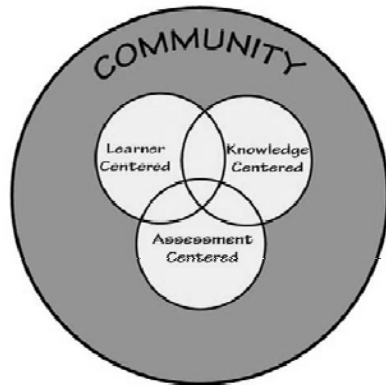
Sources: Bransford, Brown & Cocking. 1999. *How people learn*. National Academy Press.  
Wiggins, G. & McTighe, J. 2005. *Understanding by design*, 2ed. ASCD.



•Bransford, Vye and Bateman –  
Creating High Quality Learning  
Environments

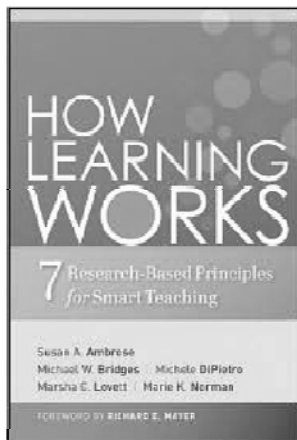
# How People Learn (HPL)

## HPL Framework



- Expertise Implies (Ch. 2):
  - a set of cognitive and metacognitive skills
  - an organized body of knowledge that is deep and contextualized
  - an ability to notice patterns of information in a new situation
  - flexibility in retrieving and applying that knowledge to a new problem

Bransford, Brown & Cocking. 1999. *How<sup>7</sup> people learn*. National Academy Press.



1. Students prior knowledge can help or hinder learning
2. How student organize knowledge influences how they learn and apply what they know
3. Students' motivation determines, directs, and sustains what they do to learn
4. To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned
5. Goal-directed practice coupled with targeted feedback enhances the quality of students' learning
6. Students' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning
7. To become self-directed learners, students must learn to monitor and adjust their approach to learning

# Understanding by Design

Wiggins & McTighe (1997, 2005)

## Stage 1. Identify Desired Results

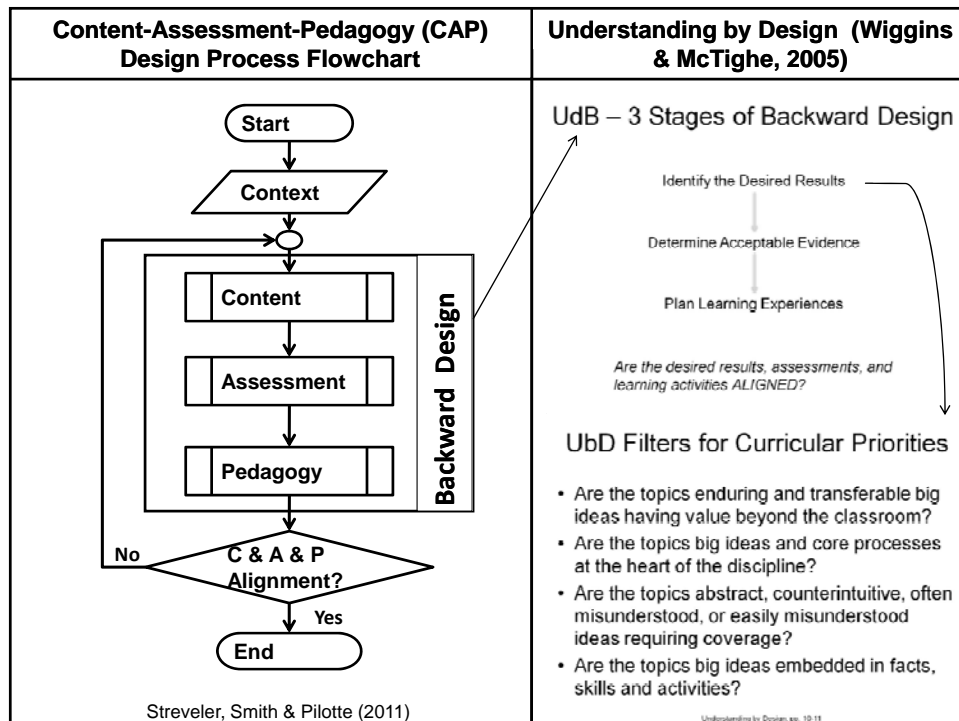
- **Enduring understanding**
- Important to know and do
- Worth being familiar with

## Stage 2. Determine Acceptable Evidence

## Stage 3. Plan Learning Experiences and Instruction

Overall: *Are the desired results, assessments, and learning activities ALIGNED?*

From: Wiggins, Grant and McTighe, Jay. 1997. *Understanding by Design*. Alexandria, VA: ASCD



# Pedagogies of Engagement



## Pedagogies of Engagement: Classroom Based Practices

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### ABSTRACT

Education researchers and practitioners have identified student involvement as the most effective and consistent aspect of successful learning. In the past decade, a new emphasis on student involvement has emerged, centered around student learning, engagement, and participation. This new emphasis is a result of a growing recognition that student learning, engagement, and participation are the most important factors in determining student success. This paper discusses the theoretical foundations of engagement, participation, and involvement, and provides a framework for understanding these concepts. The paper also discusses the research that has been conducted on these topics, and provides a framework for understanding these concepts.

Keywords: engagement, participation, student learning, student involvement

### 1. INTRODUCTION

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January 2005

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January 2005

"Throughout the whole enterprise, the core issue, in my view, is the mode of teaching and learning that is practiced. Learning 'about' things does not enable students to acquire the abilities and understanding they will need for the twenty-first century. We need new **pedagogies of engagement** that will turn out the kinds of resourceful, engaged workers and citizens that America now requires."

**Russ Edgerton** (reflecting on higher education projects funded by the Pew Memorial Trust)

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<http://www.asee.org/publications/jee/issueList.cfm?year=2005#January2005>

**Cooperative Learning** is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual and group accountability* (each member is accountable for the complete final outcome).

## Key Concepts

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

**Cooperative Learning**

Positive Interdependence	Individual Accountability
<p><b>Goal Interdependence (essential)</b></p> <ol style="list-style-type: none"> <li>1. All members share responsibility</li> <li>2. All members improve</li> <li>3. Add group member scores to get an overall group score</li> <li>4. One product from group that all helped with and can explain</li> </ol> <p><b>Role (Duty) Interdependence</b></p> <p>Assign each member a role and rotate them</p> <p><b>Resource Interdependence</b></p> <ol style="list-style-type: none"> <li>1. Limit resources (one set of materials)</li> <li>2. Jigsaw materials</li> <li>3. Separate contributions</li> </ol> <p><b>Task Interdependence</b></p> <ol style="list-style-type: none"> <li>1. Factory-line</li> <li>2. Chain Reaction</li> </ol> <p><b>Outside Challenge Interdependence</b></p> <ol style="list-style-type: none"> <li>1. Inter-group competition</li> <li>2. Other class competition</li> </ol> <p><b>Identity Interdependence</b></p> <p>Mutual identity (name, motto, etc.)</p> <p><b>Environmental Interdependence</b></p> <ol style="list-style-type: none"> <li>1. Designated classroom space</li> <li>2. Group has special meeting place</li> </ol> <p><b>Fantasy Interdependence</b></p> <p>Hypothetical interdependence in situation ("You are a scientific/literary prize team. Lost on the moon, etc.")</p> <p><b>Reward/Celebration Interdependence</b></p> <ol style="list-style-type: none"> <li>1. Celebrate joint success</li> <li>2. Bonus points (use with care)</li> <li>3. Single group grade (when fair to all)</li> </ol>	<p><b>Ways to ensure no slackers:</b></p> <ul style="list-style-type: none"> <li>• Keep group size small (2-4)</li> <li>• Assign roles</li> <li>• Randomly ask one member of the group to explain the learning</li> <li>• Have students do work before group meets</li> <li>• Have students use their group learning to do an individual task afterward</li> <li>• Everyone signs: "I participated, I agree, and I can explain"</li> <li>• Observe &amp; record individual contributions</li> </ul> <p><b>Ways to ensure that all members learn:</b></p> <ul style="list-style-type: none"> <li>• Practice tests</li> <li>• Edit each other's work and sign agreement</li> <li>• Randomly check one paper from each group</li> <li>• Give individual tests</li> <li>• Assign the role of <b>checker</b> who has each group member explain out loud</li> <li>• Simultaneous explaining: each student explains their learning to a new partner</li> </ul> <p><b>Face-to-Face Interaction</b></p> <p><b>Structure:</b></p> <ul style="list-style-type: none"> <li>• Time for groups to meet</li> <li>• Group members close together</li> <li>• Small group size of two or three</li> <li>• Frequent oral rehearsal</li> <li>• Strong positive interdependence</li> <li>• Commitment to each other's learning</li> <li>• Positive social skill use</li> <li>• Celebrations for encouragement, effort, help, and success!</li> </ul>

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## Cooperative Learning

### Positive Interdependence

- Goal Interdependence (essential)**
1. All members share responsibility
  2. All members improve
  3. Add group member scores to get an overall group score
  4. One product from group that all helped with and can explain
- Role (Duty) Interdependence**
- Assign each member a role and rotate them
- Resource Interdependence**
1. Limit resources (one set of materials)
  2. Jigsaw materials
  3. Separate contributions
- Task Interdependence**
1. Factory-line
  2. Chain Reaction
- Outside Challenge Interdependence**
1. Inter-group competition
  2. Other class competition
- Identity Interdependence**
- Mutual identity (name, motto, etc.)
- Environmental Interdependence**
1. Designated classroom space
  2. Group has special meeting place
- Fantasy Interdependence**
- Hypothetical interdependence in situation ("You are a scientific/literary prize team. Lost on the moon, etc.")
- Reward/Celebration Interdependence**
1. Celebrate joint success
  2. Bonus points (use with care)
  3. Single group grade (when fair to all)

### Individual Accountability

- Ways to ensure no slackers:**
- Keep group size small (2-4)
  - Assign roles
  - Randomly ask one member of the group to explain the learning
  - Have students do work before group meets
  - Have students use their group learning to do an individual task afterward
  - Everyone signs: "I participated, I agree, and I can explain"
  - Observe & record individual contributions

### Ways to ensure that all members learn:

- Practice tests
- Edit each other's work and sign agreement
- Randomly check one paper from each group
- Give individual tests
- Assign the role of **checker** who has each group member explain out loud
- Simultaneous explaining: each student explains their learning to a new partner

### Face-to-Face Interaction

- Structure:**
- Time for groups to meet
  - Group members close together
  - Small group size of two or three
  - Frequent oral rehearsal
  - Strong positive interdependence
  - Commitment to each other's learning
  - Positive social skill use
  - Celebrations for encouragement, effort, help, and success!

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<http://www.ce.umn.edu/~smith/docs/Smith-CL%20Handout%2008.pdf>

## Reflection and Dialogue

- Individually reflect on your familiarity with (1) Integrated Course Design and (2) Pedagogies of Engagement, especially Cooperative Learning. Write for about 1 minute
  - Key ideas, insights, applications – Success Stories
  - Questions, concerns, challenges
- Discuss with your neighbor for about 2 minutes
  - Select one Insight, Success Story, Comment, Question, etc. that you would like to present to the whole group if you are randomly selected

## Understanding by Design

### **Stage 2. Determine Acceptable Evidence**

Types of Assessment

#### Quiz and Test Items:

Simple, content-focused test items

#### Academic Prompts:

Open-ended questions or problems that require the student to think critically

#### Performance Tasks or Projects:

Complex challenges that mirror the issues or problems faced by graduates, they are authentic

## Feedback and Assessment

- Forward Looking Assessment
  - Questions that incorporate course concepts in a real-life context
- Criteria and Standards
  - What traits or characteristics are indicative of high quality work?
- Self-Assessment
  - Allow students to gauge their own learning.
- FIDeLity Feedback
  - **F**requent, **I**mmEDIATE, **D**iscriminating, **L**ovingly delivered

## Taxonomies of Types of Learning

Bloom's taxonomy of educational objectives: Cognitive Domain  
(Bloom & Krathwohl, 1956)

***A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives (Anderson & Krathwohl, 2001).***

Facets of understanding (Wiggins & McTighe, 1998)

Taxonomy of significant learning (Fink, 2003)

Evaluating the quality of learning: The SOLO taxonomy (Biggs & Collis, 1982)

**The Six Major Levels of Bloom's Taxonomy of the Cognitive Domain  
(with representative behaviors and sample objectives)**

**Knowledge.** Remembering information *Define, identify, label, state, list, match*

Identify the standard peripheral components of a computer  
Write the equation for the Ideal Gas Law

**Comprehension.** Explaining the meaning of information *Describe, generalize, paraphrase, summarize, estimate*

In one sentence explain the main idea of a written passage  
Describe in prose what is shown in graph form

**Application.** Using abstractions in concrete situations *Determine, chart, implement, prepare, solve, use, develop*

Using principles of operant conditioning, train a rat to press a bar  
Derive a kinetic model from experimental data

**Analysis.** Breaking down a whole into component parts *Points out, differentiate, distinguish, discriminate, compare*

Identify supporting evidence to support the interpretation of a literary passage  
Analyze an oscillator circuit and determine the frequency of oscillation

**Synthesis.** Putting parts together to form a new and integrated whole *Create, design, plan, organize, generate, write*

Write a logically organized essay in favor of euthanasia  
Develop an individualized nutrition program for a diabetic patient

**Evaluation.** Making judgments about the merits of ideas, materials, or phenomena *Appraise, critique, judge, weigh, evaluate, select*

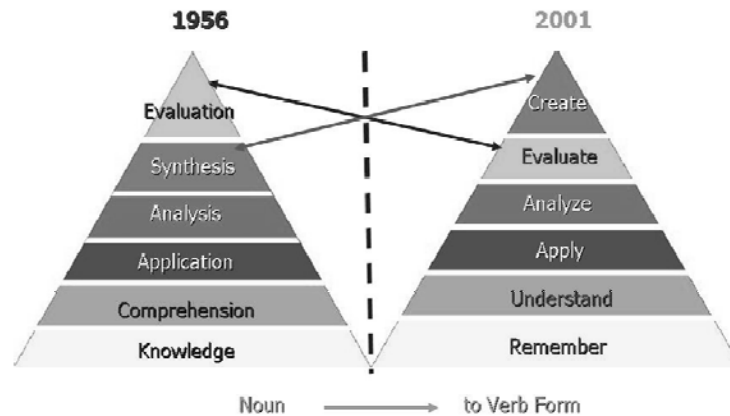
Assess the appropriateness of an author's conclusions based on the evidence given  
Select the best proposal for a proposed water treatment plant

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**— The Cognitive Process Dimension —→**

	Remember	Understand	Apply	Analyze	Evaluate	Create
<b>— The Knowledge Dimension —↓</b>						
<b>Factual Knowledge</b> – The basic elements that students must know to be acquainted with a discipline or solve problems in it. a. Knowledge of terminology b. Knowledge of specific details and elements						
<b>Conceptual Knowledge</b> – The interrelationships among the basic elements within a larger structure that enable them to function together. a. Knowledge of classifications and categories b. Knowledge of principles and generalizations c. Knowledge of theories, models, and structures						
<b>Procedural Knowledge</b> – How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods. a. Knowledge of subject-specific skills and algorithms b. Knowledge of subject-specific techniques and methods c. Knowledge of criteria for determining when to use appropriate procedures						
<b>Metacognitive Knowledge</b> – Knowledge of cognition in general as well as awareness and knowledge of one's own cognition. a. Strategic knowledge b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge c. Self-knowledge		20	(Anderson & Krathwohl, 2001).			

## Changes to Bloom's



<http://www.uwsp.edu/education/wilson/curric/newtaxonomy.htm>

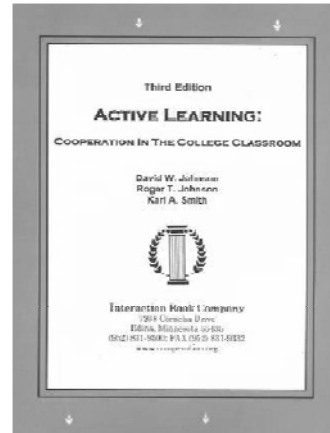
## Understanding by Design

### Stage 3. Plan Learning Experiences & Instruction

- What enabling knowledge (facts, concepts, and principles) and skills (procedures) will students need to perform effectively and achieve desired results?
- What activities will equip students with the needed knowledge and skills?
- What will need to be taught and coached, and how should it be taught, in light of performance goals?
- What materials and resources are best suited to accomplish these goals?
- Is the overall design coherent and effective?

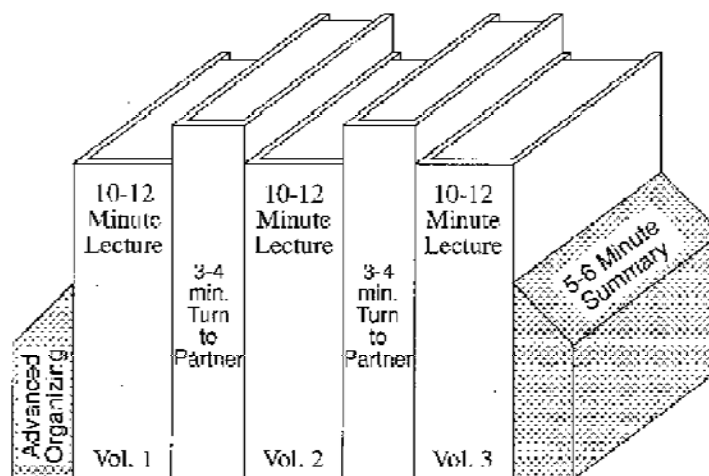
## Active Learning: Cooperation in the College Classroom

- **Informal** Cooperative Learning Groups
- **Formal** Cooperative Learning Groups
- Cooperative **Base** Groups



See Cooperative Learning Handout (CL College-804.doc) 23

## Book Ends on a Class Session



Smith, K.A. 2000. Going deeper: Formal small-group learning in large classes: From small groups to learning communities. *New Directions for Teaching and Learning*, 2000, 81, 25-46. [NDTL81Ch3GoingDeeper.pdf] 24

## **Book Ends on a Class Session**

1. Advance Organizer
2. Formulate-Share-Listen-Create (Turn-to-your-neighbor) -- repeated every 10-12 minutes
3. Session Summary (Minute Paper)
  1. What was the most useful or meaningful thing you learned during this session?
  2. What question(s) remain uppermost in your mind as we end this session?
  3. What was the “muddiest” point in this session?

### **Advance Organizer**

“The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.”

David Ausubel - Educational psychology: A cognitive approach, 1968.

## Quick Thinks

- Reorder the steps
- Paraphrase the idea
- Correct the error
- Support a statement
- Select the response

Johnston, S. & Cooper, J. 1997. Quick thinks: Active-thinking in lecture classes and televised instruction. Cooperative learning and college teaching, 8(1), 2-7.

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## Formulate-Share-Listen-Create

Informal Cooperative Learning Group  
Introductory Pair Discussion of a

### ***FOCUS QUESTION***

1. Formulate your response to the question **individually**
2. Share your answer with a partner
3. Listen carefully to your partner's answer
4. Work together to Create a new answer through discussion

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## Minute Paper

- What was the most useful or meaningful thing you learned during this session?
- What question(s) remain uppermost in your mind as we end this session?
- What was the “muddiest” point in this session?
- Give an example or application
- Explain in your own words . . .

Angelo, T.A. & Cross, K.P. 1993. Classroom assessment techniques: A handbook for college teachers. San Francisco: Jossey Bass.

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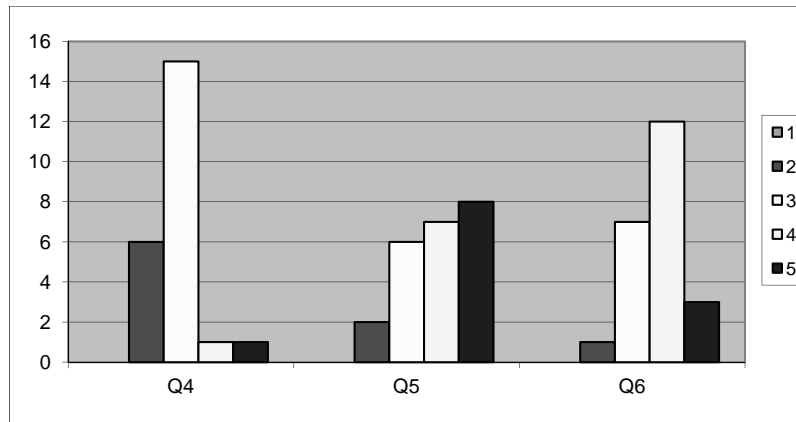
## Session Summary (Minute Paper)

Reflect on the session:

1. Most interesting, valuable, useful thing you learned.
2. Things that helped you learn.
3. Question, comments, suggestions.
4. Pace: Too slow 1 . . . . 5 Too fast
5. Relevance: Little 1 . . . 5 Lots
6. Instructional Format: Ugh 1 . . . 5 Ah

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MOT 8221 – Spring 2011 – Session 1 (3/25/11)



Q4 – Pace: Too slow 1 . . . 5 Too fast (2.9)

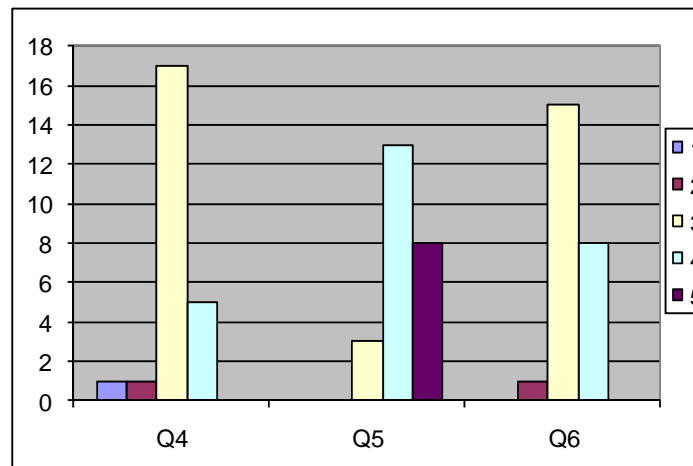
Q5 – Relevance: Little 1 . . . 5 Lots (3.9)

Q6 – Format: Ugh 1 . . . 5 Ah (3.7)

## Minute Paper – Reflection

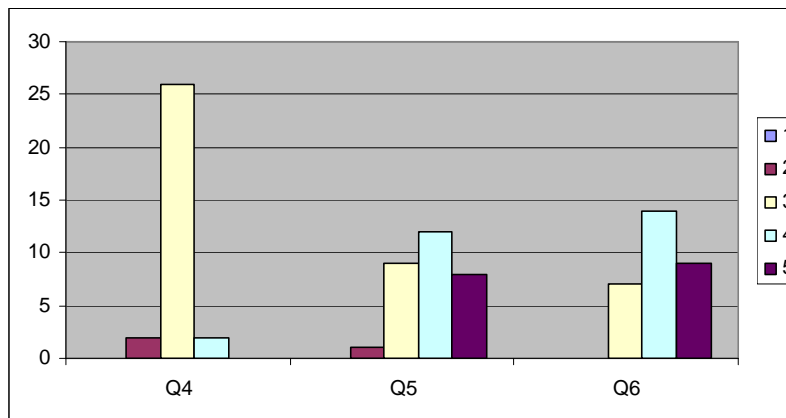
1. Most interesting, valuable, useful thing you learned.
2. Question/Topic/Issue you would like to have addressed
3. Current challenge, comments, suggestions, etc.
4. Pace: Too Slow 1 2 3 4 5 Too Fast
5. Relevance: Low 1 2 3 4 5 High
6. Discussion Control: Too Low 1 2 3 4 5 Too High

MOT 8221 – Spring 2011 – Session 2 (4/8/11)



Q4 – Pace: Too slow 1 . . . . 5 Too fast (3.1)  
 Q5 – Relevance: Little 1 . . . 5 Lots (4.2)  
 Q6 – Discussion Control: Too Low 1 . . . 5 Too High (3.3)

MOT 8221 – Spring 2010 – Session 1 (1/29/10)



Q4 – Pace: Too slow 1 . . . . 5 Too fast (3.0)  
 Q5 – Relevance: Little 1 . . . 5 Lots (3.9)  
 Q6 – Format: Ugh 1 . . . 5 Ah (4.1)

## Informal CL (Book Ends on a Class Session) with Concept Tests

### Physics

Peer Instruction

Eric Mazur - Harvard – <http://galileo.harvard.edu>

Peer Instruction – [www.prenhall.com](http://www.prenhall.com)

Richard Hake – <http://www.physics.indiana.edu/~hake/>

### Chemistry

Chemistry ConcepTests - UW Madison

[www.chem.wisc.edu/~concept](http://www.chem.wisc.edu/~concept)

Video: Making Lectures Interactive with ConcepTests

ModularChem Consortium – <http://mc2.cchem.berkeley.edu/>

### STEMTEC

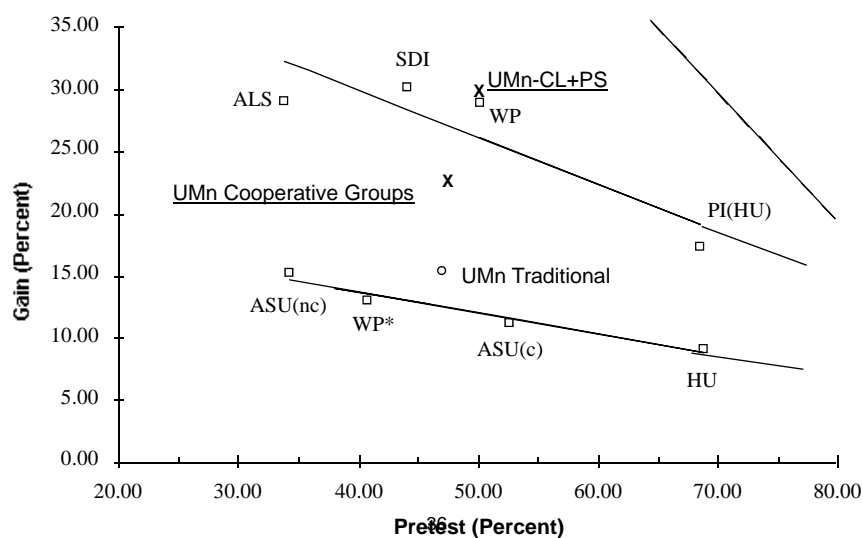
Video: How Change Happens: Breaking the “Teach as You Were Taught” Cycle – Films for the Humanities & Sciences – [www.films.com](http://www.films.com)

### Harvard – Derek Bok Center

Thinking Together & From Questions to Concepts: Interactive Teaching in Physics

– [www.fas.harvard.edu/~bok\\_cen/](http://www.fas.harvard.edu/~bok_cen/) 35

## The “Hake” Plot of FCI



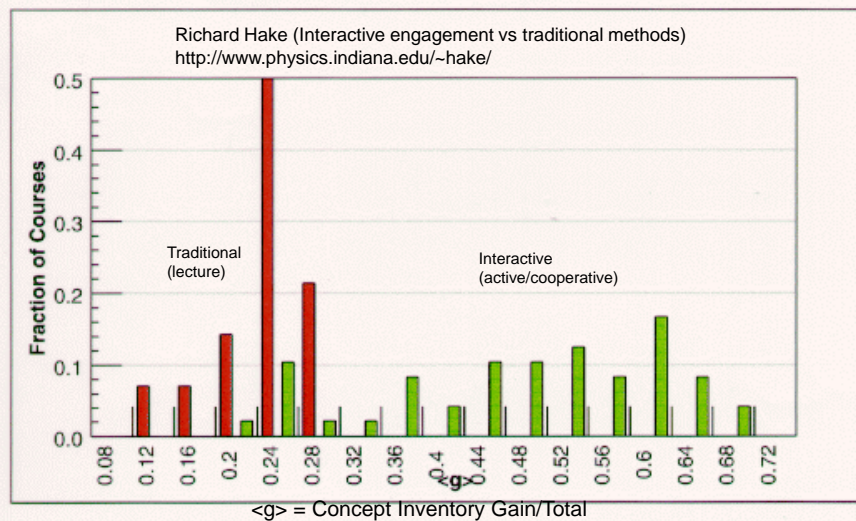


Fig. 2. Histogram of the average normalized gain  $\langle g \rangle$ : dark (red) bars show the fraction of 14 traditional courses (N = 2084), and light (green) bars show the fraction of 48 interactive engagement courses (N = 4458), both within bins of width  $\delta \langle g \rangle = 0.04$  centered on the  $\langle g \rangle$  values shown.

### III. CONCEPTUAL TEST RESULTS

#### A. Gain vs Pretest Graph - All Data

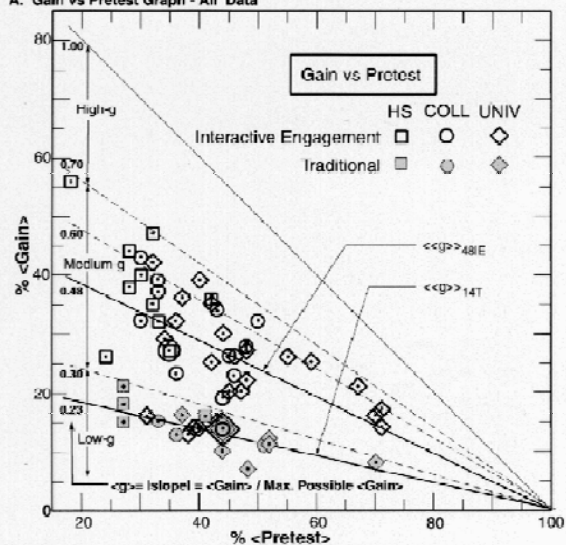


Fig. 1. % Gain vs % Pretest score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total N = 6042 students: 14 traditional (T) courses (N = 2084) which made little or no use of interactive engagement (IE) methods, and 48 IE courses (N = 4458) which made considerable use of IE methods. Slope lines for the average of the 14 T courses  $\langle g \rangle_{14T}$  and 48 IE courses  $\langle g \rangle_{48IE}$  are shown, as explained in the text.

## Physics (Mechanics) Concepts: The Force Concept Inventory (FCI)

- A 30 item multiple choice test to probe student's understanding of basic concepts in mechanics.
- The choice of topics is based on careful thought about what the fundamental issues and concepts are in Newtonian dynamics.
- Uses common speech rather than cueing specific physics principles.
- The distractors (wrong answers) are based on students' common inferences.

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## Informal Cooperative Learning Groups

Can be used at any time

Can be short term and ad hoc

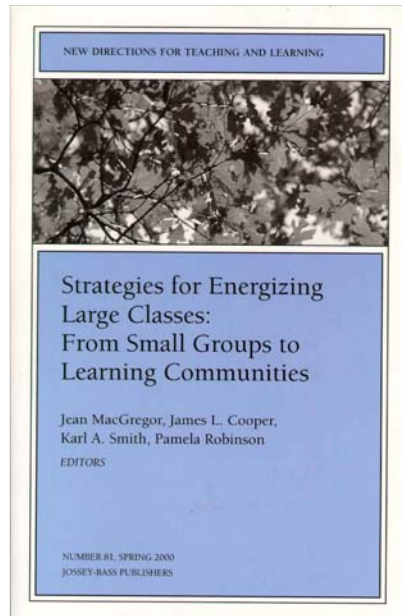
May be used to break up a long lecture

**Provides an opportunity for students to process material they have been listening to (Cognitive Rehearsal)**

Are especially effective in large lectures

Include "book ends" procedure

Are not as effective as Formal Cooperative Learning or Cooperative Base Groups



***Strategies for  
Energizing Large  
Classes: From Small  
Groups to  
Learning Communities:***

Jean MacGregor,  
James Cooper,  
Karl Smith,  
Pamela Robinson

*New Directions for  
Teaching and Learning,*  
No. 81, 2000.  
Jossey- Bass

## Active Learning: Cooperation in the College Classroom

- **Informal**  
Cooperative  
Learning Groups
- ⇒ • **Formal** Cooperative  
Learning Groups
- Cooperative **Base**  
Groups



See Cooperative Learning  
Handout (CL College-804.doc) 42

# Formal Cooperative Learning Task Groups

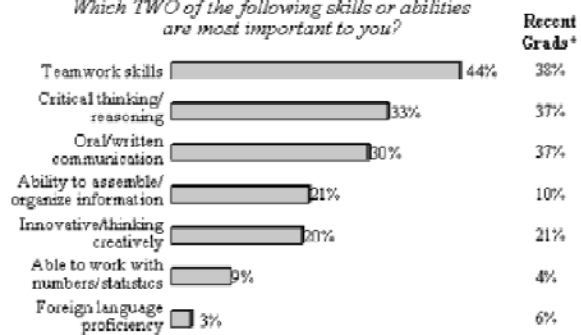


**How Should Colleges Prepare Students To Succeed In Today's Global Economy?**  
*Recent Ph.D. Research Shows Improving And Impact Career Outcomes*  
*Conducted On Behalf Of:*  
*The Association Of American Colleges And Universities*  
*By Peter D. Hart Research Associates, Inc.*  
*December 20, 2006*

Peter D. Hart Research Associates, Inc.  
 1700 Connecticut Avenue, NW  
 Washington, DC 20009

## Most Important Skills Employers Look For In New Hires

*Which TWO of the following skills or abilities are most important to you?*



\* Skills/abilities recent graduates think are the two most important to employers

<http://www.aacu.org/advocacy/leap/documents/Re8097abcombined.pdf>

## Top Three Main Engineering Work Activities

### Engineering Total

- Design – 36%
- Computer applications – 31%
- Management – 29%

### Civil/Architectural

- Management – 45%
- Design – 39%
- Computer applications – 20%

Burton, L., Parker, L., & LeBold, W. 1998.  
U.S. engineering career trends. *ASEE Prism*, 7(9), 18-21.



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## Teamwork Skills

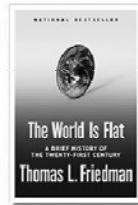
- Communication
  - Listening and Persuading
- Decision Making
- Conflict Management
- Leadership
- Trust and Loyalty



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Ideo's five-point model for strategizing by design:  
**Hit the Streets**  
**Recruit T-Shaped People**  
**Build to Think**  
**The Prototype Tells a Story**  
**Design Is Never Done**



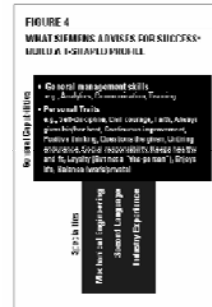
Tom Friedman  
 Horizontalize  
 Ourselves

$CQ+PQ>IQ$

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## Design Thinking

Discipline Thinking



AAC&U College Learning  
 For the New Global Century

## Professor's Role in Formal Cooperative Learning

1. Specifying Objectives
2. Making Decisions
3. Explaining Task, Positive Interdependence, and Individual Accountability
4. Monitoring and Intervening to Teach Skills
5. Evaluating Students' Achievement and Group Effectiveness

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### **Formal Cooperative Learning – Types of Tasks**

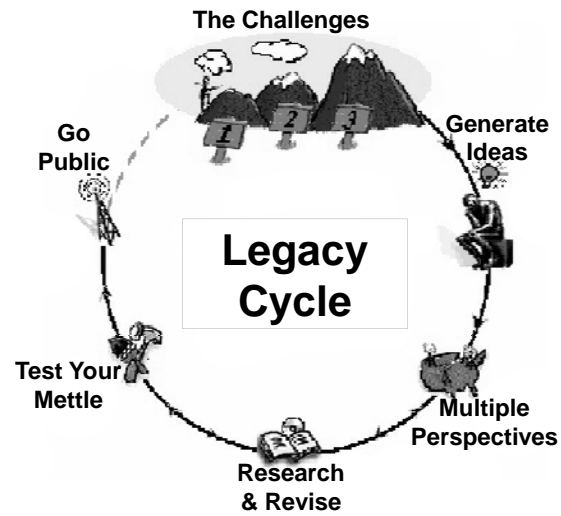
1. Jigsaw – Learning new conceptual/procedural material
2. Peer Composition or Editing
3. Reading Comprehension/Interpretation
4. **Problem Solving, Project, or Presentation**
5. Review/Correct Homework
6. Constructive Academic Controversy
7. Group Tests

### **Challenge-Based Learning**

- Problem-based learning
- Case-based learning
- Project-based learning
- Learning by design
- Inquiry learning
- Anchored instruction

John Bransford, Nancy Vye and Helen Bateman. Creating High-Quality Learning Environments: Guidelines from Research on How People Learn

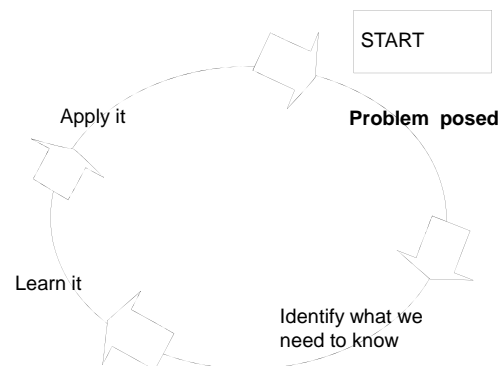
## Challenge-Based Instruction with the Legacy Cycle



<https://repo.vanth.org/portal/public-content/star-legacy-cycle/star-legacy-cycle>

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## Problem-Based Learning



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# Problem-Based Cooperative Learning

## At M.I.T., Large Lectures Are Going the Way of the Blackboard



The Massachusetts Institute of Technology has changed the way it offers some introductory classes. And, it's all thanks to the New York Times.

By GABRIELLE SCOBIE  
Published January 13, 2009

CAMBRIDGE, Mass. For as long as anyone can remember, introductory physics at the Massachusetts Institute of Technology was taught in a vast windowless amphitheater hewn by its founder,

COMMENTS (55)  
EMAIL  
PRINT  
LINK PAGE

January 13, 2009—New York Times — <http://www.nytimes.com/2009/01/13/us/13physics.html?em>

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<http://web.mit.edu/edtech/casestudies/teal.html#video>

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## PROBLEM-BASED LEARNING

[UD PBL articles and books](#)

[UD PBL in the news](#)

[Sample PBL problems](#)

[UD PBL courses and syllabi](#)

[PBL Clearinghouse](#)

[PBL Conferences and  
Other PBL sites](#)

[Institute for Transforming  
Undergraduate Education](#)

[Other related UD sites](#)

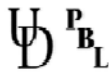
"How can I get my students to think?" is a question asked by many faculty, regardless of their disciplines. Problem-based learning (PBL) is an instructional method that challenges students to "learn to learn," working cooperatively in groups to seek solutions to real world problems. These problems are used to engage students' curiosity and initiate learning the subject matter. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources. -- *Barbara Duch*



**PBL2002:  
A Pathway to Better Learning**



**Recipient of 1999 Hesburgh  
Certificate of Excellence**



Please direct comments, suggestions, or requests to [ud\\_pbl@udel.edu](mailto:ud_pbl@udel.edu)  
<http://www.udel.edu/pbl/>  
 Last updated March 15, 2004  
 © The University of Delaware, 1999

<http://www.udel.edu/pbl/>

## Problem-Based Cooperative Learning

**Karl A. Smith**

Engineering Education – Purdue University

Civil Engineering - University of Minnesota

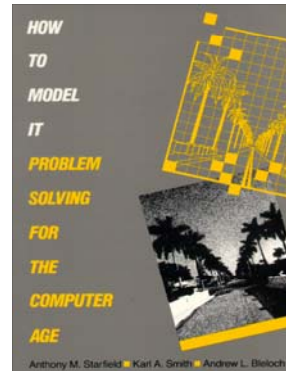
[ksmith@umn.edu](mailto:ksmith@umn.edu)

<http://www.ce.umn.edu/~smith>

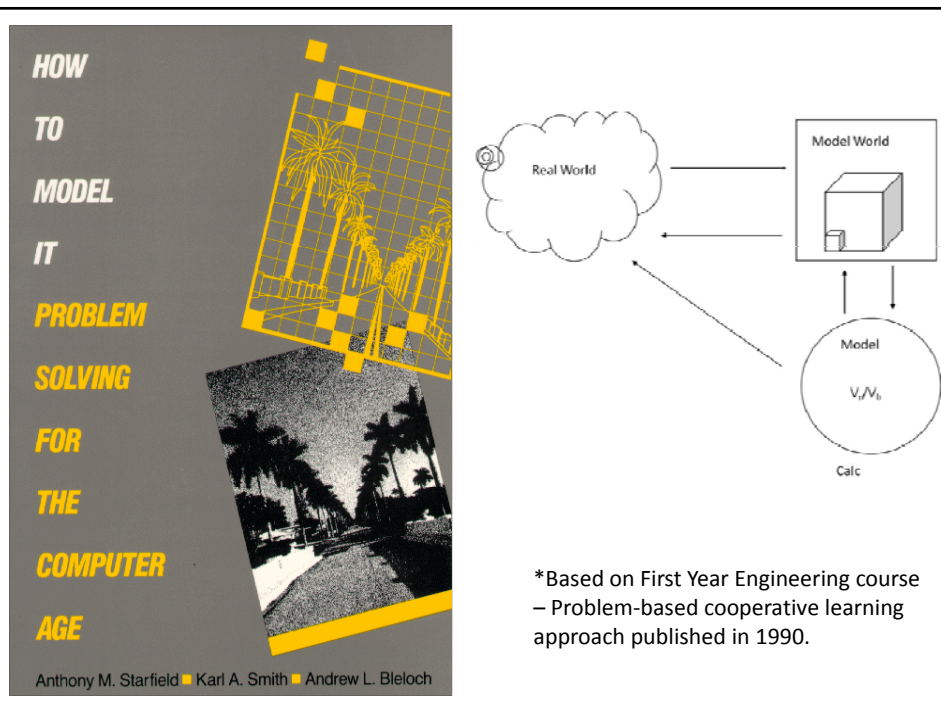
## Estimation Exercise

## First Course Design Experience UMN – Institute of Technology

- Thinking Like an Engineer
- Problem Identification
- Problem Formulation
- Problem Representation
- Problem Solving



Problem-Based Learning



## Problem Based Cooperative Learning Format

**TASK:** Solve the problem(s) or Complete the project.

**INDIVIDUAL:** Estimate answer. Note strategy.

**COOPERATIVE:** One set of answers from the group, strive for agreement, make sure everyone is able to explain the strategies used to solve each problem.

**EXPECTED CRITERIA FOR SUCCESS:** Everyone must be able to explain the strategies used to solve each problem.

**EVALUATION:** Best answer within available resources or constraints.

**INDIVIDUAL ACCOUNTABILITY:** One member from your group may be randomly chosen to explain (a) the answer and (b) how to solve each problem.

**EXPECTED BEHAVIORS:** Active participating, checking, encouraging, and elaborating by all members.

**INTERGROUP COOPERATION:** Whenever it is helpful, check procedures, answers, and strategies with another group.

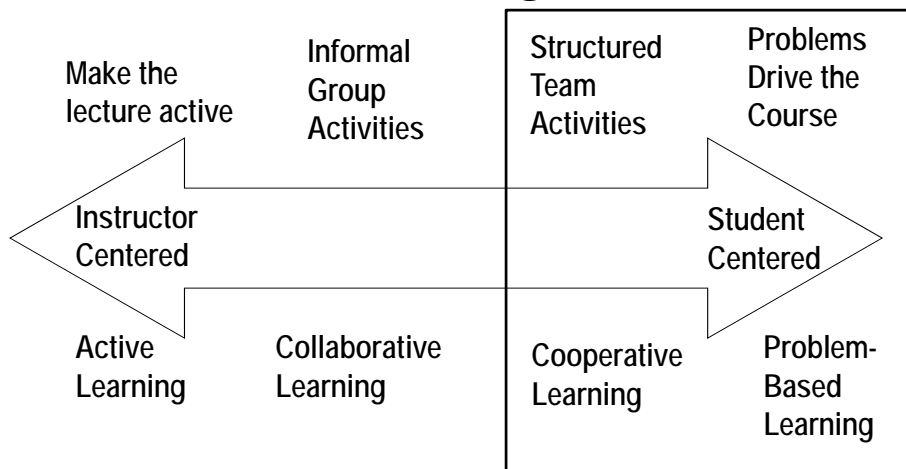
## Cooperative Base Groups

- Are Heterogeneous
- Are Long Term (at least one quarter or semester)
- Are Small (3-5 members)
- Are for support
- May meet at the beginning of each session or may meet between sessions
- Review for quizzes, tests, etc. together
- Share resources, references, etc. for individual projects
- Provide a means for covering for absentees

## Designing and Implementing Cooperative Learning

- Think like a designer
- Ground practice in robust theoretical framework
- Start small, start early and iterate
- Celebrate the successes; problem-solve the failures

### The Active Learning Continuum



Prince, M. (2010). NAE FOEE

\*My work is situated here – Cooperative Learning & Challenge-Based Learning

## Design and Implementation of Cooperative Learning – Resources

- Design Framework – How People Learn (HPL) & Backward Design Process
  - Streveler, R.A., Smith, K.A. and Pilotte, M. 2011. Aligning Course Content, Assessment, and Delivery: Creating a Context for Outcome-Based Education – <http://www.ce.umn.edu/~smith/links.html>
  - Bransford, Vye & Bateman. 2002. Creating High Quality Learning Environments -- <http://www.nap.edu/openbook/0309082927/html/>
  - Pellegrino – Rethinking and redesigning curriculum, instruction and assessment: What contemporary research and theory suggests. <http://www.skillscommission.org/commissioned.htm>
  - Smith, K. A., Douglas, T. C., & Cox, M. 2009. Supportive teaching and learning strategies in STEM education. In R. Baldwin, (Ed.). Improving the climate for undergraduate teaching in STEM fields. New Directions for Teaching and Learning, 117, 19-32. San Francisco: Jossey-Bass.
- Content Resources
  - Donald, Janet. 2002. Learning to think: Disciplinary perspectives. San Francisco: Jossey-Bass.
  - Middendorf, Joan and Pace, David. 2004. Decoding the Disciplines: A Model for Helping Students Learn Disciplinary Ways of Thinking. New Directions for Teaching and Learning, 98.
- Cooperative Learning - Instructional Format explanation and exercise to model format and to engage workshop participants
  - Cooperative Learning (Johnson, Johnson & Smith)
    - Smith web site – [www.ce.umn.edu/~smith](http://www.ce.umn.edu/~smith)
  - Smith (2010) Social nature of learning: From small groups to learning communities. New Directions for Teaching and Learning, 2010, 123, 11-22 [[NDTL-123-2-Smith-Social Basis of Learning-.pdf](#)]
  - Smith, Sheppard, Johnson & Johnson (2005) Pedagogies of Engagement [[Smith-Pedagogies of Engagement.pdf](#)]
  - Cooperative learning returns to college: What evidence is there that it works? Change, 1998, 30 (4), 26-35. [[CLReturnstoCollege.pdf](#)]
- Other Resources
  - University of Delaware PBL web site – [www.udel.edu/pbl](http://www.udel.edu/pbl)
  - PKAL – Pedagogies of Engagement – <http://www.pkal.org/activities/PedagogiesOfEngagementSummit.cfm>
  - Fairweather (2008) Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education - [http://www7.nationalacademies.org/bose/Fairweather\\_CommissionedPaper.pdf](http://www7.nationalacademies.org/bose/Fairweather_CommissionedPaper.pdf)