Introduction to Cooperative Learning

Karl A. Smith
STEM Education Center / Technological Leadership Institute / Civil Engineering – University of Minnesota & Engineering Education – Purdue University
ksmith@umn.edu - http://www.ce.umn.edu/~smith

Lilly Teaching Seminar
Michigan State University

April 11, 2013

Reflection and Dialogue

- Individually reflect on Effective, Interactive Strategies for Facilitating Learning. Write for about 1 minute
  - Context? Subject, Year, School/Department
  - Structure/Procedure?
  - Outcome? Evidence of Success
- Discuss with your neighbor for about 3 minutes
  - Select Story, Comment, Question, etc. that you would like to present to the whole group if you are randomly selected

Session Objectives

- Participants will be able to :
  - Describe key features of effective, interactive strategies for facilitating learning
  - Summarize research on *How People Learn (HPL)*
  - Describe key features of the *Understanding by Design* (UbD) process – Content (outcomes) – Assessment – Pedagogy
  - Explain key features of and rationale for Cooperative Learning
  - Identify connections between cooperative learning and desired outcomes of courses and programs
- Participants will begin applying key elements to the design on a course, class session or learning module

3

Seven Principles for Good Practice in Undergraduate Education

- Good practice in undergraduate education:
  - Encourages student-faculty contact
  - Encourages cooperation among students
  - Encourages active learning
  - Gives prompt feedback
  - Emphasizes time on task
  - Communicates high expectations
  - Respects diverse talents and ways of learning

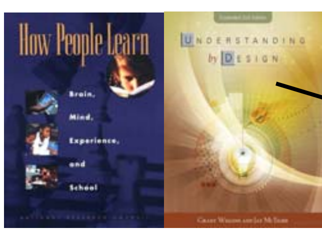
Chickering & Gamson, June, 1987
http://learningcommons.evergreen.edu/pdf/fall1987.pdf

4

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]

Design Foundations



Science of Learning (HPL)	Science of Instruction (UbD): No	Science of Instruction (UbD): Yes
Yes	Good Theory/ Poor Practice	Good Theory & Good Practice
No		Good Practice/ Poor Theory

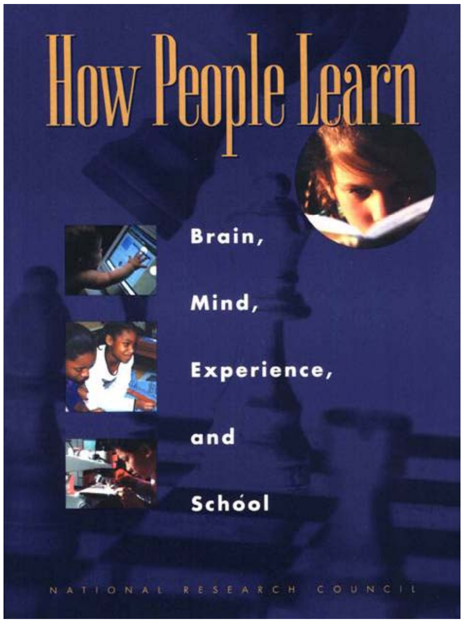
Sources: Bransford, Brown & Cocking. 1999. *How people learn.* National Academy Press.
Wiggins, G. & McTighe, J. 2005. *Understanding by design, 2ed*. ASCD.

Part I – Introduction
1 Learning: From Speculation to Science 3

Part II – Learners and Learning
2 How Experts Differ from Novices 31
3 Learning and Transfer 51
4 How Children Learn 79
5 Mind and Brain 114

Part III – Teachers and Teaching
6 The Design of Learning Environments 131
7 Effective Teaching: Examples in History, Mathematics, and Science 155
8 Teacher Learning 190
9 Technology to Support Learning 206

Part IV – Future Directions for the Science of Learning
10 Conclusions 233
11 Next Steps for Research 248

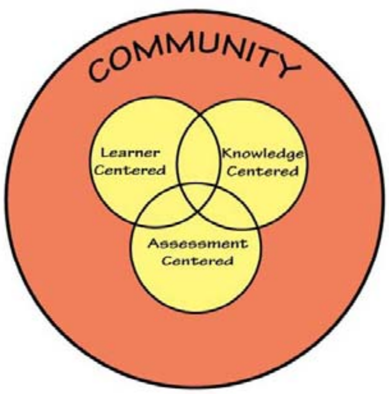


http://www.nap.edu/openbook.php?record_id=6160

7

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 people learn.* National Academy Press.

8

Understanding by Design

Wiggins & McTighe (1997, 2005)

Stage 1. Identify Desired Results

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

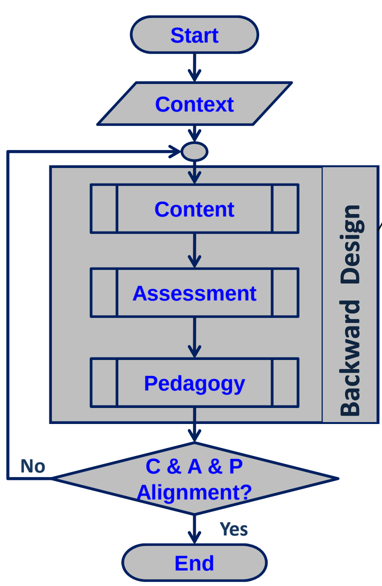
Stage 2. Determine Acceptable Evidence

Stage 3. Plan Learning Experiences and Instruction

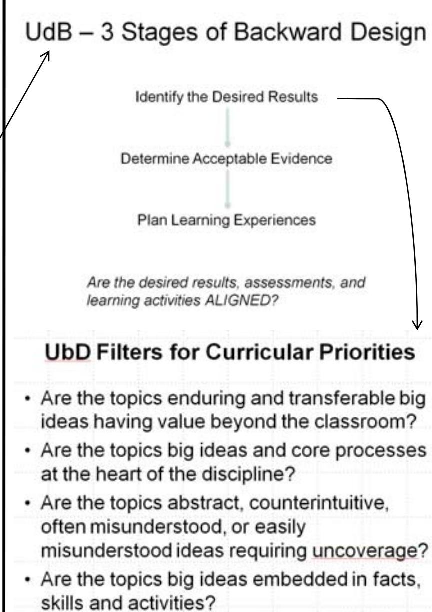
Overall: *Are the desired results, assessments, and learning activities ALIGNED?*

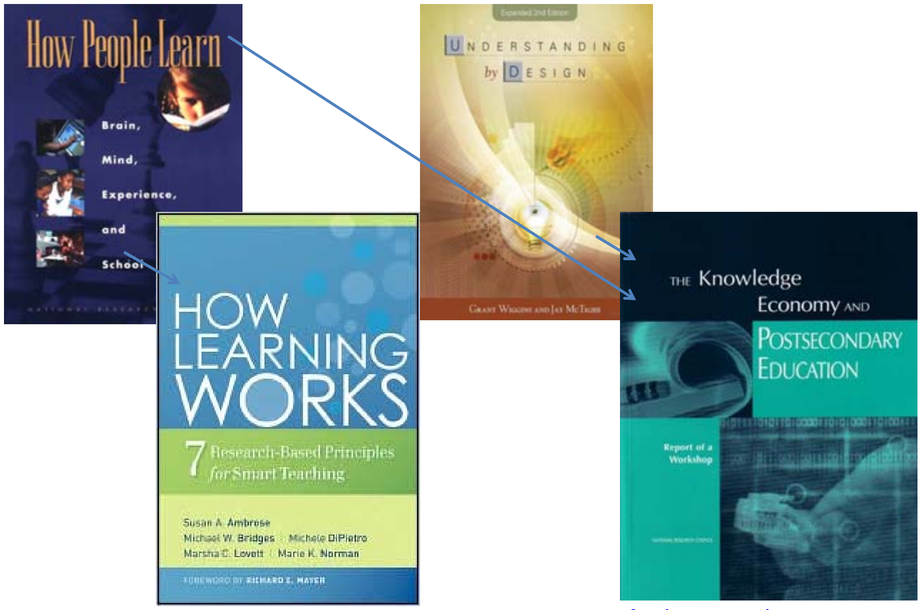
From: Wiggins, Grant and McTighe, Jay. 1997. *Understanding by Design*. Alexandria, VA: ASCD

Content-Assessment-Pedagogy (CAP) Design Process Flowchart	Understanding by Design (Wiggins & McTighe, 2005)

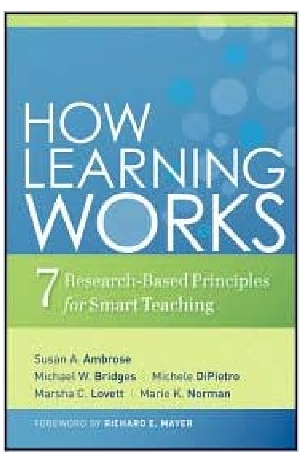


Streveler, Smith & Pilotte (2012)

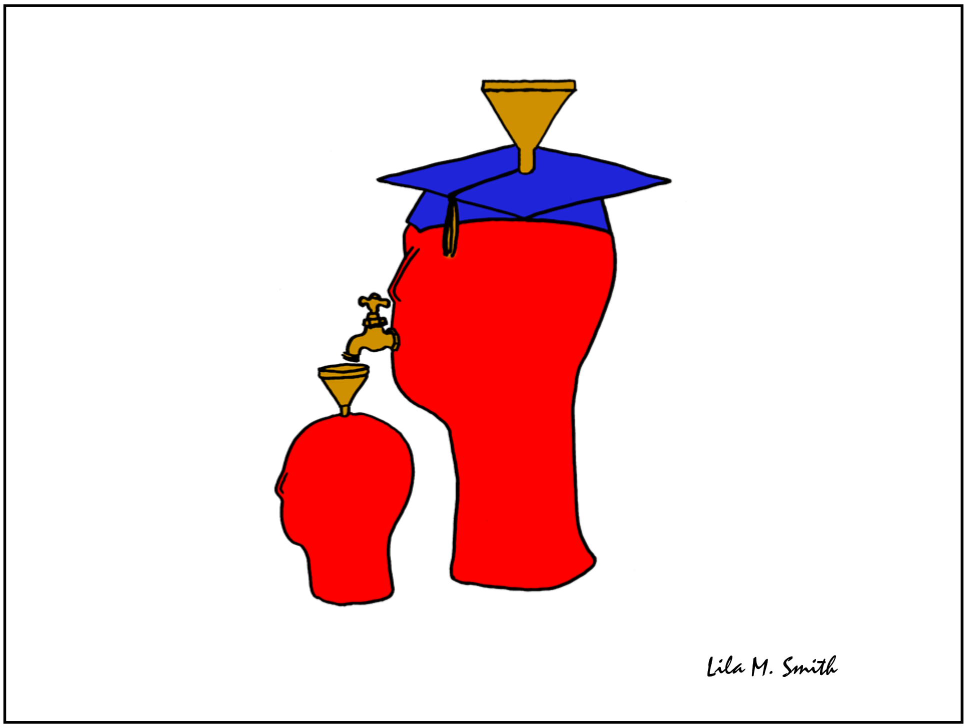




•Bransford, Vye and Bateman – Creating High Quality Learning Environments



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

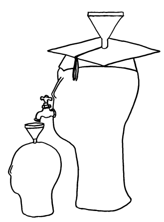


Pedago-pathologies

Amnesia

Fantasia

Inertia



Lee Shulman – MSU Med School – PBL Approach (late 60s – early 70s), President Emeritus of the Carnegie Foundation for the Advancement of College Teaching

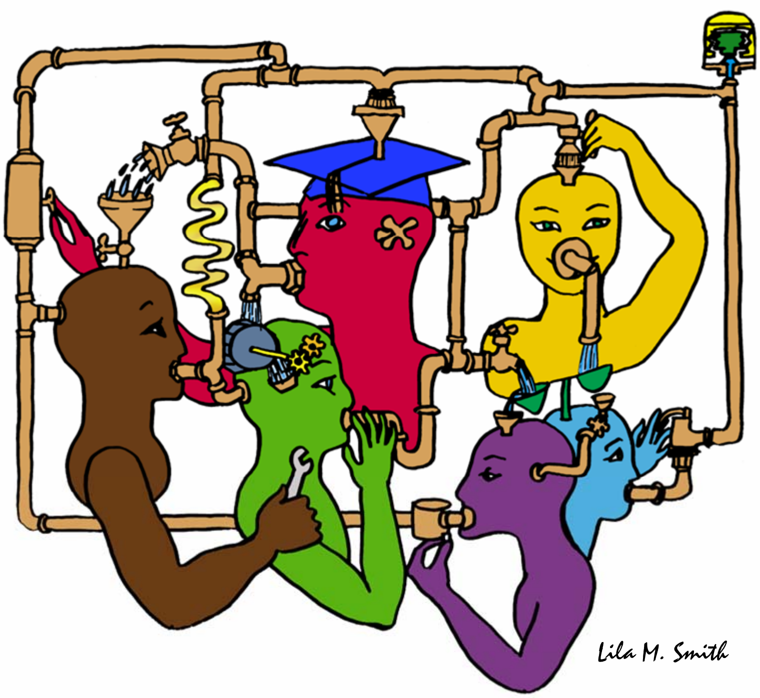
Shulman, Lee S. 1999. Taking learning seriously. *Change, 31* (4), 11-17.

What do we do about these pathologies?

- **Activity** – Engage learners in meaningful and purposeful activities
- **Reflection** – Provide opportunities
- **Collaboration** – Design interaction
- **Passion** – Connect with things learners care about

Shulman, Lee S. 1999. Taking learning seriously. Change, 31 (4), 11-17.

15



Pedagogies of Engagement

Student Engagement Research Evidence

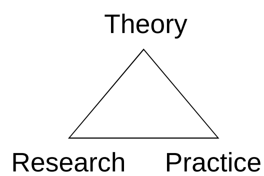
- Perhaps the strongest conclusion that can be made is the least surprising. Simply put, the greater the student's involvement or engagement in academic work or in the academic experience of college, the greater his or her level of knowledge acquisition and general cognitive development …(Pascarella and Terenzini, 2005).
- Active and collaborative instruction coupled with various means to encourage student engagement invariably lead to better student learning outcomes irrespective of academic discipline (Kuh et al., 2005, 2007).

See Smith, et.al, 2005 and Fairweather, 2008, Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education - http://www7.nationalacademies.org/bose/Fairweather_CommissionedPaper.pdf

18

Cooperative Learning

- Theory – Social Interdependence – Lewin – Deutsch – Johnson & Johnson
- Research – Randomized Design Field Experiments
- Practice – Formal Teams/Professor's Role



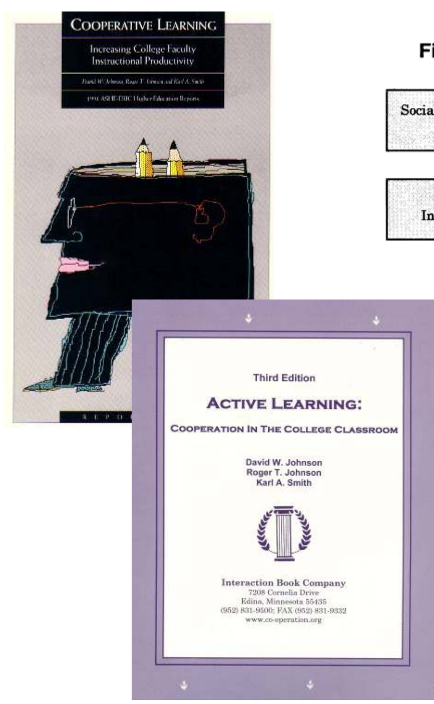
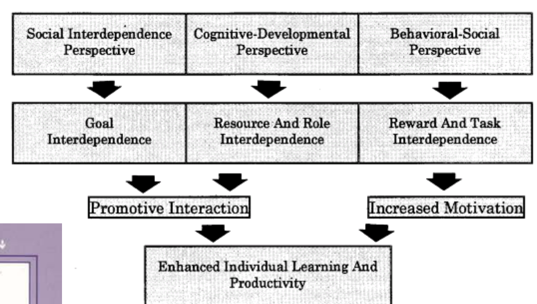


Figure A.1 A General Theoretical Framework



Cooperative Learning

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

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

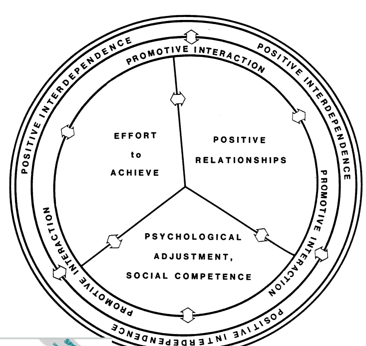
- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

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

Cooperative Learning Research Support

Johnson, D.W., Johnson, R.T., & Smith, K.A. 1998. Cooperative learning returns to college: What evidence is there that it works? *Change*, *30* (4), 26-35.

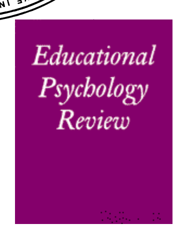
- Over 300 Experimental Studies
- First study conducted in 1924
- High Generalizability
- Multiple Outcomes



Outcomes

1. Achievement and retention
2. Critical thinking and higher-level reasoning
3. Differentiated views of others
4. Accurate understanding of others' perspectives
5. Liking for classmates and teacher
6. Liking for subject areas
7. Teamwork skills

January 2005



March 2007

Informal Cooperative Learning

EDUCATION

Farewell, Lecture?

Eric Mazur

A physics professor describes his evolution from lecturing to dynamically engaging students during class and improving how they learn.

Discussions of education are generally predicated on the assumption that we know what education is. I hope to convince you otherwise by recounting some of my own experiences. When I started teaching introductory physics to undergraduates at Harvard University, I never asked myself how I would educate my students. I did what my teachers had done—I lectured. I thought that was how one learns. Look around anywhere in the world and you'll find lecture halls filled with students and, at the front, an instructor. This approach to education has not changed since before the Renaissance and the birth of scientific inquiry. Early in my career I received the first hints that something was wrong with teaching in this manner, but I had ignored it. Sometimes it's hard to face reality.

When I started teaching, I prepared lecture notes and then taught from them. Because my lectures deviated from the textbook, I provided students with copies of these lecture notes. The infuriating result was that on my end-of-semester evaluations—which were quite good otherwise—a number of students complained that I was "lecturing straight from (his) lecture notes." What was I supposed to do? Develop a set of lecture notes different from the ones I handed out? I decided to ignore the students' complaints.

A few years later, I discovered that the students were right. My lecturing was ineffective, despite the high evaluations. Early on in the physics curriculum—in week 2 of a typical introductory physics course—the Laws of Newton are presented. Every student in such a course can recite Newton's third law of motion, which states that the force of object A on object B in an interaction between two objects is equal in magnitude to the force of B on A—it sometimes is known as "action is reaction." One day, when the course had progressed to more complicated material, I decided to test my students' understanding of this concept not by doing traditional problems, but by asking them a set of basic conceptual questions (1, 2). One of the questions, for example, requires students to compare the forces that a heavy truck and a light car exert on one another when they collide. I expected that the students would have no trouble tackling such questions, but much to my surprise, hardly a minute after the test began, one student asked, "How should I answer these questions? According to what you taught me or according to the way I usually think about these things?" To my dismay, students had great difficulty with the conceptual questions. That was when it began to dawn on me that something was amiss.

In hindsight, the reason for my students' poor performance is simple. The traditional approach to teaching reduces education to a transfer of information. Before the industrial revolution, when books were not yet mass commodities, the lecture method was the only way to transfer information from one generation to the next. However, education is so

Click here. Students continually discuss concepts among themselves and with the instructor during class. Discussions are spurred by multiple-choice conceptual questions that students answer using a clicker device. See supporting online text for examples of such "clicker questions."

Department of Physics, Harvard University, Cambridge, MA 02138, USA. E-mail: mazur@physics.harvard.edu

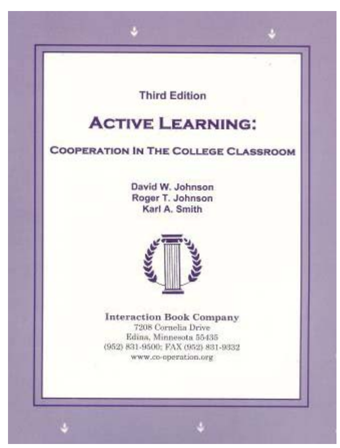
50 2 JANUARY 2009 VOL 323 SCIENCE www.sciencemag.org

January 2, 2009—Science, Vol. 323 – www.sciencemag.org

Calls for evidence-based instruction practices

Active Learning: Cooperation in the College Classroom

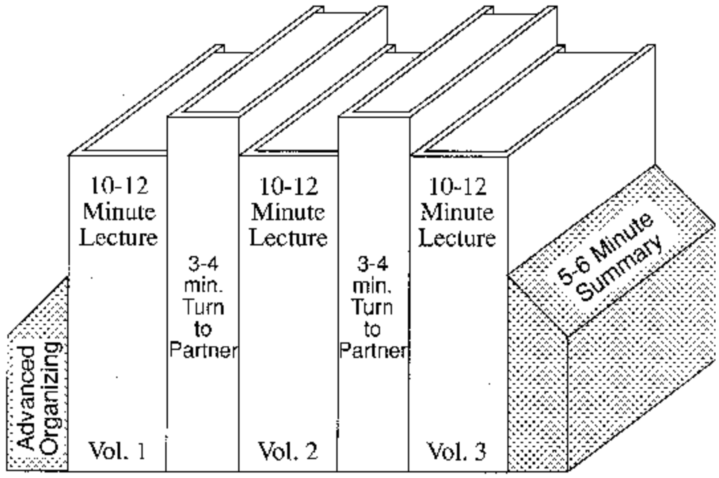
- **Informal** Cooperative Learning Groups
- **Formal** Cooperative Learning Groups
- Cooperative **Base** Groups



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

24

Book Ends on a Class Session



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

25

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?

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

27

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

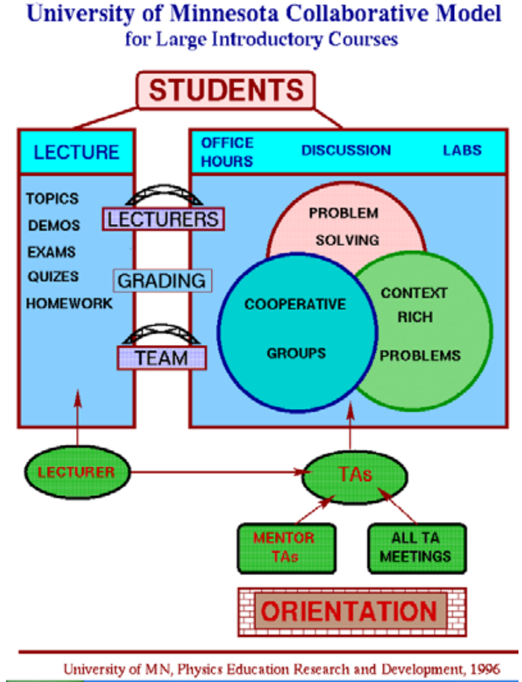
Physics
Peer Instruction
Eric Mazur - Harvard – http://galileo.harvard.edu
Peer Instruction – www.prenhall.com
Richard Hake – http://www.physics.indiana.edu/~hake/

Chemistry
Chemistry ConcepTests - UW Madison
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

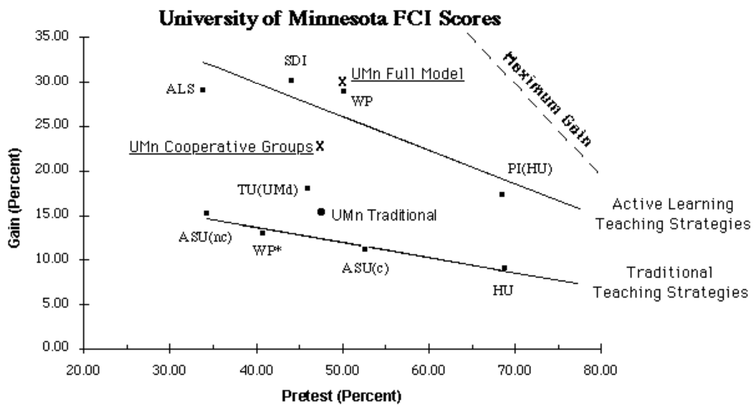
Harvard – Derek Bok Center
Thinking Together & From Questions to Concepts: Interactive Teaching in Physics – www.fas.harvard.edu/~bok_cen/

28



http://groups.physics.umn.edu/physed/Research/MNModel/Model.html

Conceptual Understanding



http://groups.physics.umn.edu/physed/Research/MNModel/FCI.html

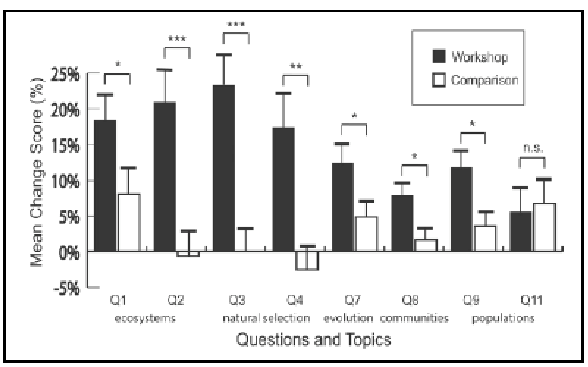
Physics (Mechanics) Concepts: The Force Concept Inventory (FCI)

- 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.

31

Workshop Biology

Traditional passive lecture vs. “Workshop biology”



Source: Udovic et al. 2002

Biology

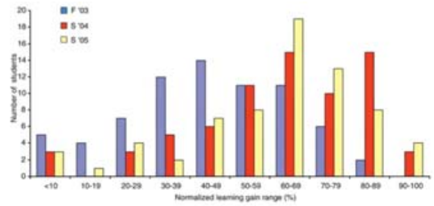


Figure 3. Comparison of normalized learning gains (% of possible maximum) in 10% increments on 12 common pretest and posttest questions for students in one traditional (F'03) and two interactive (S'04, S'05) classes. Normalized learning gains were computed as in Figure 2.

Table 4. Comparison of average performance on different assessments for all three courses

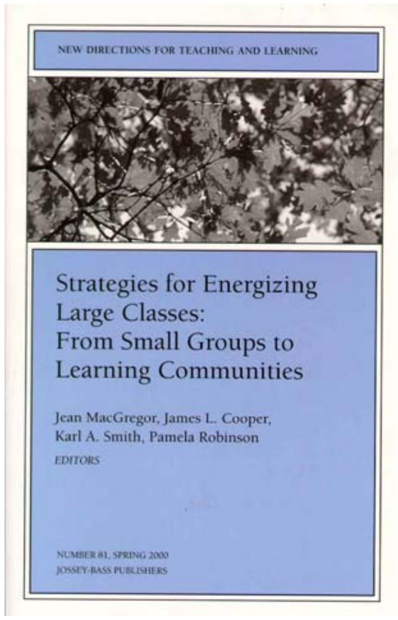
Assessment	of maximum score)		
	F'03	S'04	S'05
Pretest (12 questions)[a]	34	31	37
posttest (12 questions)[a]	65	74	72
Raw learning gain	31	43	38
Normalized learning gain[b]	46	62	61
Hourly exams	71	71	73
Final exam	77	71	76
Problem sets	82	85	90
Participation	N/A	86	86
Final total points	76	81	81

[a]Data based only on the 12 questions that were common to all three pretests and posttests (see Appendix A).
[b]Average for each class is shown. Normalized learning gains were computed as described in the text and the legend to Figure 2.

Source: Knight, J. and Wood, W. (2005). Teaching more by lecturing less. *Cell Biol Educ*. 4(4): 298–310.

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

Informal Cooperative Learning Planning Form

Description of the Lecture

1. **Lecture Topic:** ____________
2. **Objectives** (Major Understandings Students Need To Have At The End Of The Lecture):
   a. ____________
   b. ____________
3. **Time Needed:** ____________
4. **Method For Assigning Students To Pairs Or Triads:** ____________
5. **Method Of Changing Partners Quickly:** ____________
6. **Materials** (such as transparencies listing the questions to be discussed and describing the **formulate, share, listen, create** procedure): ____________

Advanced Organizer Question(s)

Questions should be aimed at promoting **advance organizing** of what the students know about the topic to be presented and **establishing expectations** as to what the lecture will cover.

1. ____________
2. ____________
3. ____________

Cognitive Rehearsal Questions

List the specific questions to be asked every 10 or 15 minutes to ensure that participants understand and process the information being presented. Instruct students to use the **formulate, share, listen, and create** procedure.

1. ____________
2. ____________
3. ____________
4. ____________

Monitor by systematically observing each pair. Intervene when it is necessary. Collect data for whole class processing. Students' explanations to each other provide a window into their minds that allows you to see what they do and do not understand. Monitoring also provides an opportunity for you to get to know your students better.

Summary Question(s)

Give an ending discussion task and require students to come to consensus, write down the pair or triad's answer(s), sign the paper, and hand it in. Signatures indicate that students agree with the answer, can explain it, and guarantee that their partner(s) can explain it. The questions could (a) ask for a summary, elaboration, or extension of the material presented or (b) precue the next class session.

1. ____________
2. ____________

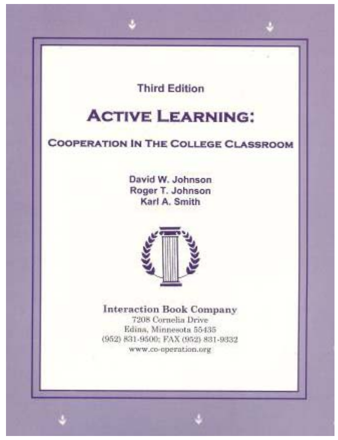
Celebrate Students' Hard Work

1. ____________
2. ____________

36

Active Learning: Cooperation in the College Classroom

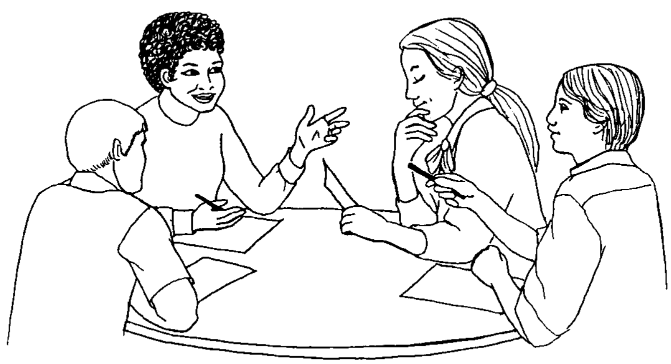
- **Informal** Cooperative Learning Groups
- **Formal** Cooperative Learning Groups
- Cooperative **Base** Groups



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

37

Formal Cooperative Learning Task Groups



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

39

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 Controversy
7. **Group Tests**

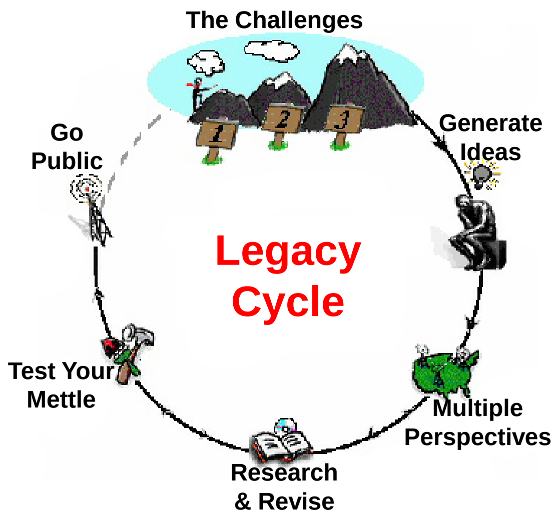
Challenge-Based Learning

- 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

41

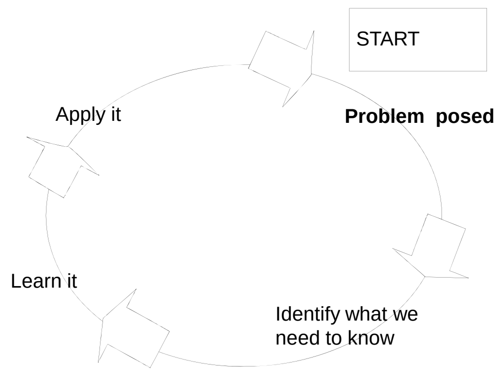
Challenge-Based Instruction with the Legacy Cycle



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

42

Problem-Based Learning



43

Problem-Based Cooperative Learning

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

Jodi Hilton for The New York Times

The Massachusetts Institute of Technology has changed the way it offers some introductory classes. Prof. Gabriella Sciolla at a class on electricity and magnetism.

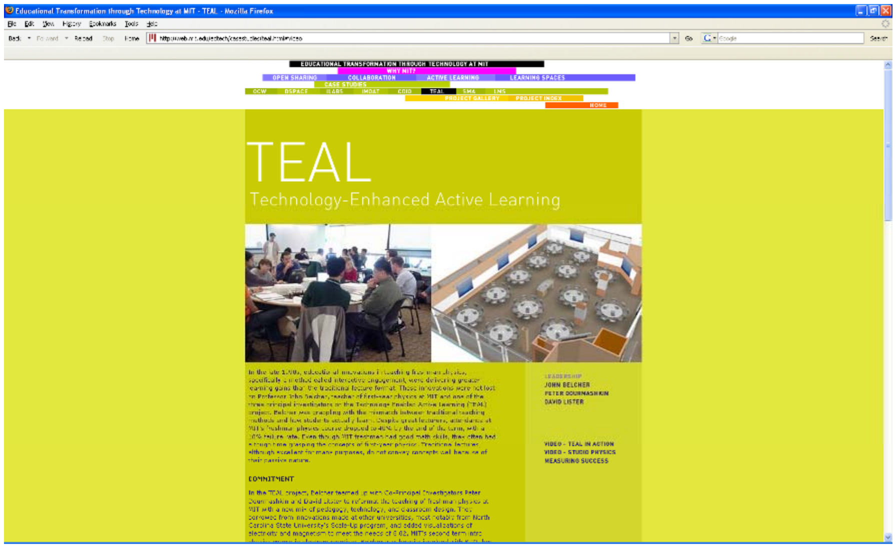
By SARA RIMER
Published: January 12, 2009

COMMENTS (00)
E-MAIL
PRINT
SINGLE PAGE

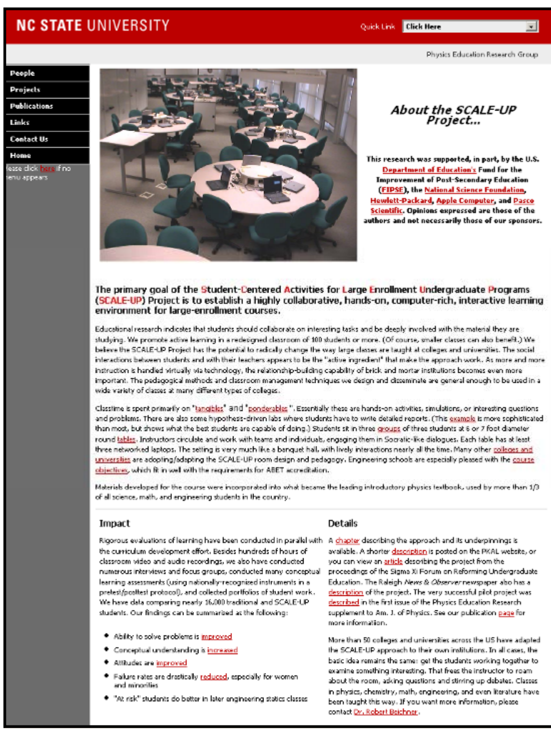
CAMBRIDGE, Mass. — For as long as anyone can remember, introductory physics at the Massachusetts Institute of Technology was taught in a vast windowless amphitheater known by its number,

44

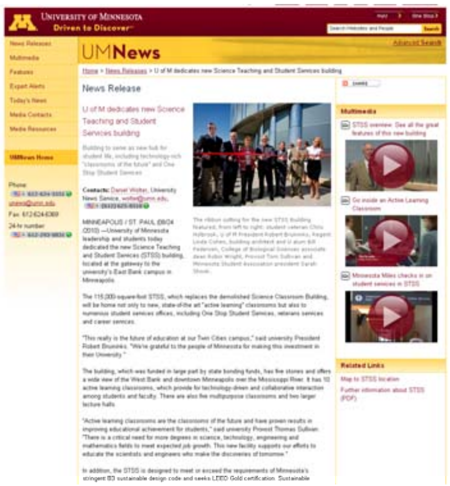
January 13, 2009—New York Times – http://www.nytimes.com/2009/01/13/us/13physics.html?em

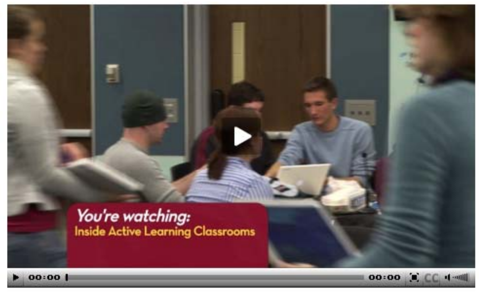


http://web.mit.edu/edtech/casestudies/teal.html#video



http://www.ncsu.edu/PER/scaleup.html





http://mediamill.cla.umn.edu/mediamill/embed/78755

http://www1.umn.edu/news/news-releases/2010/UR_CONTENT_248261.html

http://www.youtube.com/watch?v=lfT_hoiuY8w

http://youtu.be/lfT_hoiuY8w

47

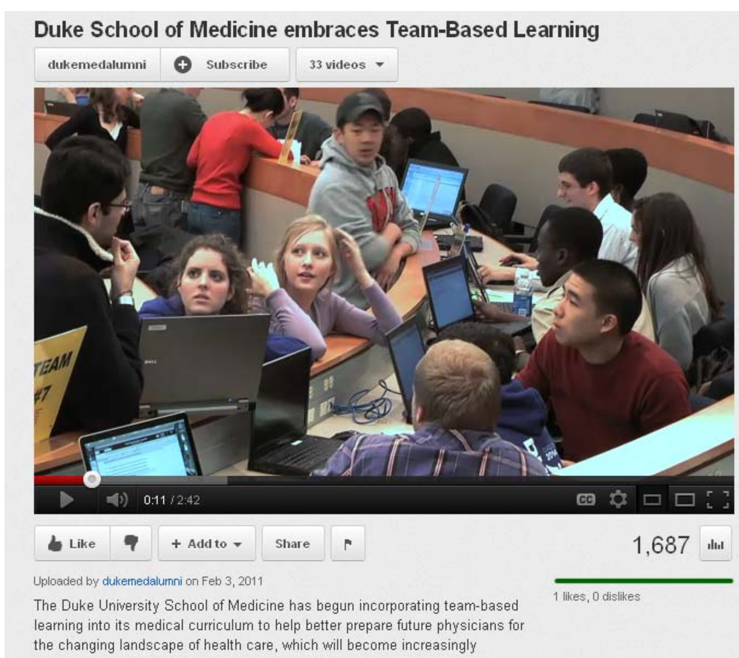
Inside an Active Learning Classroom

- STSS in University of Minnesota

http://vimeo.com/andyub/activeclassroom

"I love this space! It makes me feel appreciated as a student, and I feel intellectually invigorated when I work and learn in it."

http://www.udel.edu/inst/



http://www.youtube.com/watch?v=gW_M426V2E0&feature=related

Problem-Based Cooperative Learning

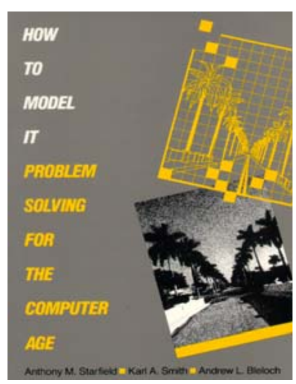
Karl A. Smith
Engineering Education – Purdue University
Civil Engineering - University of Minnesota
ksmith@umn.edu
http://www.ce.umn.edu/~smith

Estimation Exercise

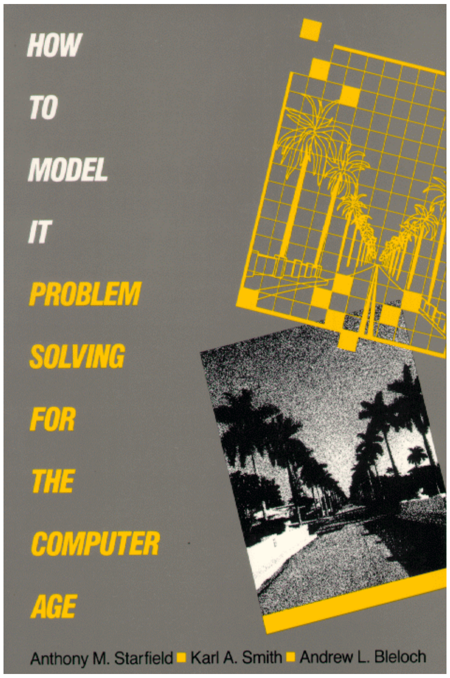
51

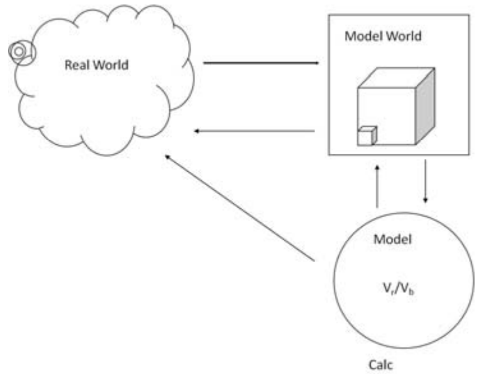
First Course Design Experience UMN – Institute of Technology

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



Problem-Based Learning





*Based on First Year Engineering course – Problem-based cooperative learning *How to Model It* published in 1990.

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.

54

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

55

Does Psychological Safety Hinder Performance?

Psychological safety does not operate at the expense of employee accountability; the most effective organizations achieve high levels of both, as this matrix shows.

Edmonson-Competitive_Advantage_of_Learning-HBR-2008.pdf

Accountability for Meeting Demanding Goals

Psychological Safety	LOW	HIGH
HIGH	**Comfort zone** Employees really enjoy working with one another but don't feel particularly challenged. Nor do they work very hard. Some family businesses and small consultancies fall into this quadrant.	**Learning zone** Here the focus is on collaboration and learning in the service of high-performance outcomes. The hospitals described in this article fall into this quadrant.
LOW	**Apathy zone** Employees tend to be apathetic and spend their time jockeying for position. Typical organizations in this quadrant are large, top-heavy bureaucracies, where people fulfill their functions but the preferred modus operandi is to curry favor rather than to share ideas.	**Anxiety zone** Such firms are breeding grounds for anxiety. People fear to offer tentative ideas, try new things, or ask colleagues for help, even though they know great work requires all three. Some investment banks and high-powered consultancies fall into this quadrant.

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 Instructor's Role in Cooperative Learning

Make Pre-Instructional Decisions

Specify Academic and Teamwork Skills Objectives: Every lesson has both (a) academic and (b) interpersonal and small group (teamwork) skills objectives.

Decide on Group Size: Learning groups should be small (groups of two or three members, four at the most).

Decide on Group Composition (Assign Students to Groups): Assign students to groups randomly or select groups yourself. Usually you will wish to maximize the heterogeneity in each group.

Assign Roles: Structure student-student interaction by assigning roles such as Reader, Recorder, Encourager of Participation and Checker for Understanding.

Arrange the Room: Group members should be "knee to knee and eye to eye" but arranged so they all can see the instructor at the front of the room.

Plan Materials: Arrange materials to give a "sink or swim together" message. Give only one paper to the group or give each member part of the material to be learned.

Explain Task And Cooperative Structure

Explain the Academic Task: Explain the task, the objectives of the lesson, the concepts and principles students need to know to complete the assignment and the procedures they are to follow.

Explain the Criteria for Success: Student work should be evaluated on a criteria-referenced basis. Make clear your criteria for evaluating students' work.

***Structure Positive Interdependence**: Students must believe they "sink or swim together." Always establish mutual goals (students are responsible for their own learning and the learning of all other group members). Supplement, goal interdependence with celebration/reward, resource, role, and identity interdependence.

Structure Intergroup Cooperation: Have groups check with and help other groups. Extend the benefits of cooperation to the whole class.

***Structure Individual Accountability**: Each student must feel responsible for doing his or her share of the work and helping the other group members. Ways to ensure accountability are frequent oral quizzes of group members picked at random, individual tests, and assigning a member the role of Checker for Understanding.

***Specify Expected Behaviors**: The more specific you are about the behaviors you want to see in the groups, the more likely students will do them. Social skills may be classified as **forming** (staying with the group, using quiet voices), **functioning** (contributing, encouraging others to participate), **formulating** (summarizing, elaborating), and **fermenting** (criticizing ideas, asking for justification). Regularly teach the interpersonal and small group skills you wish to see used in the learning groups.

Monitor and Intervene

***Arrange Face-to-Face Promotive Interaction**: Conduct the lesson in ways that ensure that students promote each other's success face-to-face.

Monitor Students' Behavior: This is the fun part! While students are working, you circulate to see whether they understand the assignment and the material, give immediate feedback and reinforcement, and praise good use of group skills. Collect observation data on each group and student.

Intervene to Improve Taskwork and Teamwork: Provide **taskwork assistance** (clarify, reteach) if students do not understand the assignment. Provide **teamwork assistance** if students are having difficulties in working together productively.

Evaluate and Process

Evaluate Student Learning: Assess and evaluate the quality and quantity of student learning. Involve students in the assessment process.

***Process Group Functioning**: Ensure each student receives feedback, analyzes the data on group functioning, sets an improvement goal, and participates in a team celebration. Have groups routinely list three things they did well in working together an done thing they will do better tomorrow. Summarize as a whole class. Have groups celebrate their success and hard work.

59

Cooperative Lesson Planning Form

Subject Area: ______________________ Date: __________

Lesson: ______________________________

Objectives

Academic: ______________________________

Social Skills: ______________________________

Preinstructional Decisions

Group Size: ________ Method Of Assigning Students: ____________

Roles: ______________________________

Room Arrangement: ______________________________

Materials: ______________________________

- ◊ One Copy Per Group
- ◊ One Copy Per Person
- ◊ Jigsaw
- ◊ Tournament
- ◊ Other: ______________

Explain Task And Cooperative Goal Structure

1. Task: ______________________________
2. Criteria For Success: ______________________________
3. Positive Interdependence: ______________________________
4. Individual Accountability: ______________________________
5. Intergroup Cooperation: ______________________________
6. Expected Behaviors: ______________________________

Monitoring And Intervening

1. Observation Procedure: _____ Formal _____ Informal
2. Observation By: _____ Teacher _____ Students _____ Visitors
3. Intervening For Task Assistance: ______________________________
4. Intervening For Teamwork Assistance: ______________________________
5. Other: ______________________________

Evaluating And Processing

1. Assessment Of Members' Individual Learning: ______________________________
2. Assessment Of Group Productivity: ______________________________
3. Small Group Processing: ______________________________
4. Whole Class Processing: ______________________________
5. Charts And Graphs Used: ______________________________
6. Positive Feedback To Each Student: ______________________________
7. Goal Setting For Improvement: ______________________________
8. Celebration: ______________________________
9. Other: ______________________________

60

The American College Teacher:

National Norms for 2007-2008

Methods Used in “All” or “Most”	All – 2005	All – 2008	Assistant - 2008
Cooperative Learning	48	59	66
Group Projects	33	36	61
Grading on a curve	19	17	14
Term/research papers	35	44	47

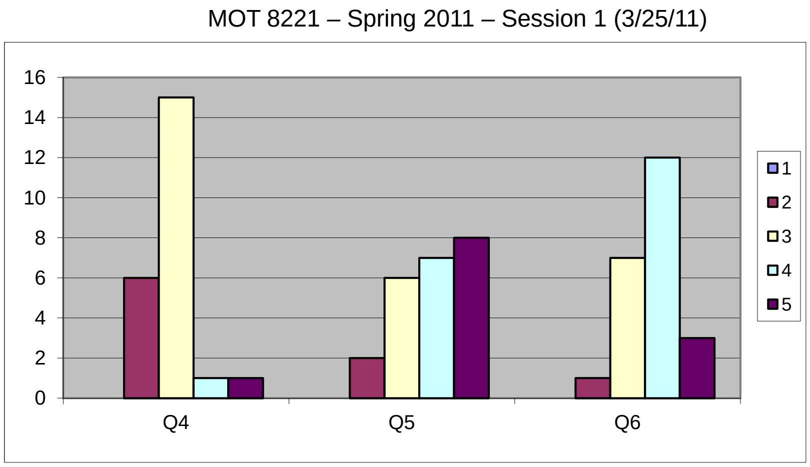
http://www.heri.ucla.edu/index.php

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



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)

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)

64

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 rate 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

65

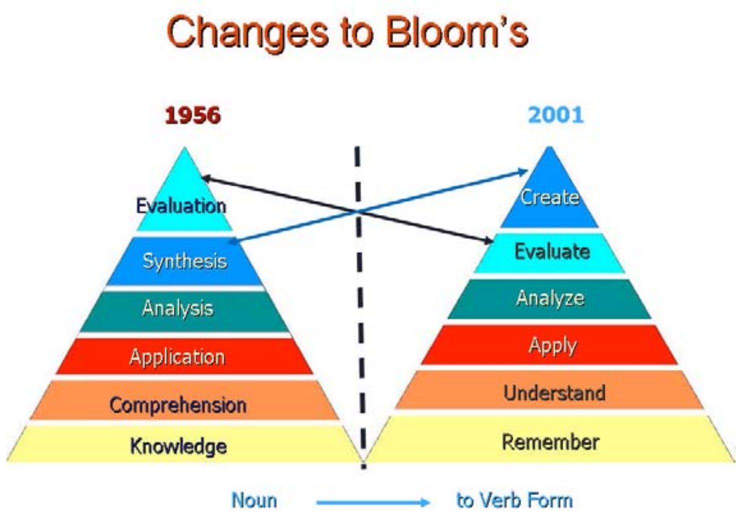
The Cognitive Process Dimension →

The Knowledge Dimension ↓

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge – 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						
Conceptual Knowledge – 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						
Procedural Knowledge – 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						
Metacognitive Knowledge – 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						

(Anderson & Krathwohl, 2001).

66



http://www.uwsp.edu/education/lwilson/curric/newtaxonomy.htm

67

A Model of Learning Objectives

based on

A Taxonomy for Learning, Teaching, and Assessing:
A Revision of Bloom's Taxonomy of Educational Objectives

Among other modifications, Anderson and Krathwohl's (2001) revision of the original Bloom's taxonomy (Bloom & Krathwohl, 1956) redefines the cognitive domain as the intersection of the Cognitive Process Dimension and the Knowledge Dimension. This document offers a three-dimensional representation of the revised taxonomy of the cognitive domain.

Although the Cognitive Process and Knowledge dimensions are represented as hierarchical steps, the distinctions between categories are not always clear-cut. For example, all procedural knowledge is not necessarily more abstract than all conceptual knowledge; and an objective that involves analyzing or evaluating may require thinking skills that are no less complex than one that involves creating. It is generally understood, nonetheless, that lower order thinking skills are subsumed by, and provide the foundation for higher order thinking skills.

The Knowledge Dimension classifies four types of knowledge that learners may be expected to acquire or construct—ranging from concrete to abstract (Table 1).

Table 1. The Knowledge Dimension – major types and subtypes

concrete knowledge →			abstract knowledge
factual	**conceptual**	**procedural**	**metacognitive***
knowledge of terminology knowledge of specific details and elements	knowledge of classifications and categories knowledge of principles and generalizations knowledge of theories, models, and structures	knowledge of subject-specific skills and algorithms knowledge of subject-specific techniques and methods knowledge of criteria for determining when to use appropriate procedures	strategic knowledge knowledge about cognitive tasks, including appropriate contextual and conditional knowledge self-knowledge

(Table 1 adapted from Anderson and Krathwohl, 2001, p. 46.)
*Metacognitive knowledge is a special case. In this model, "metacognitive knowledge is knowledge of [one's own] cognition and about oneself in relation to various subject matters . . ." (Anderson and Krathwohl, 2001, p. 44).

IOWA STATE UNIVERSITY
Center for Excellence in Learning and Teaching

http://www.celt.iastate.edu/pdfs-docs/teaching/RevisedBloomsHandout.pdf

68

This taxonomy provides a framework for determining and clarifying learning ***objectives***.
Learning ***activities*** often involve both lower order and higher order thinking skills as well as a mix of concrete and abstract knowledge.

The Cognitive Process Dimension represents a continuum of increasing cognitive complexity—from lower order thinking skills to higher order thinking skills. Anderson and Krathwohl (2001) identify nineteen specific cognitive processes that further clarify the scope of the six categories (Table 2).

Table 2. The Cognitive Processes dimension — categories & cognitive processes and alternative names

lower order thinking skills → higher order thinking skills

remember	understand	apply	analyze	evaluate	create
recognizing • identifying recalling • retrieving	interpreting • clarifying • paraphrasing • representing • translating exemplifying • illustrating • instantiating classifying • categorizing • subsuming summarizing • abstracting • generalizing inferring • concluding • extrapolating • interpolating • predicting comparing • contrasting • mapping • matching explaining • constructing models	executing • carrying out implementing • using	differentiating • discriminating • distinguishing • focusing • selecting organizing • finding coherence • integrating • outlining • parsing • structuring attributing • deconstructing	checking • coordinating • detecting • monitoring • testing critiquing • judging	generating • hypothesizing planning • designing producing • constructing

(Table 2 adapted from Anderson and Krathwohl, 2001, pp. 67–68.)

IOWA STATE UNIVERSITY
Center for Excellence in Learning and Teaching

69

Facets of Understanding

Wiggins & McTighe, 1998, page 44

When we truly *understand*, we

Can ***explain - cognitive***

Can ***interpret - cognitive***

Can ***apply - cognitive***

Have ***perspective - affective***

Can ***empathize - affective***

Have ***self-knowledge - metacognitive***

70

Dee Fink – Creating Significant Learning Experiences

A TAXONOMY OF SIGNIFICANT LEARNING

Cognitive

1. Foundational Knowledge

- "Understand and remember" learning

  For example: facts, terms, formulae, concepts, principles, etc.

2. Application

- Thinking: critical, creative, practical (problem-solving, decision-making)
- Other skills

  For example: communication, technology, foreign language
- Managing complex projects

3. Integration

- Making "connections" (i.e., finding similarities or interactions) . . .

  Among: ideas, subjects, people

Affective

4. Human Dimensions

- Learning about and changing one's SELF
- Understanding and interacting with OTHERS

5. Caring

- Identifying/changing one's feelings, interests, values

Meta

6. Learning How to Learn

- Becoming a better student
- Learning how to ask and answer questions
- Becoming a self-directed learner

SOLO Taxonomy

- The **Structure of Observed Learning Outcome** (**SOLO**) model consists of 5 levels of understanding

Surface Learning

  - **Pre-structural** - The task is not attacked appropriately; the student hasn't really understood the point and uses too simple a way of going about it.
  - **Uni-structural** - The student's response only focuses on one relevant aspect.
  - **Multi-structural** - The student's response focuses on several relevant aspects but they are treated independently and additively. Assessment of this level is primarily quantitative.

Deep Learning

  - **Relational** - The different aspects have become integrated into a coherent whole. This level is what is normally meant by an adequate understanding of some topic.
  - **Extended abstract -** The previous integrated whole may be conceptualised at a higher level of abstraction and generalised to a new topic or area.

http://en.wikipedia.org/wiki/Structure_of_Observed_Learning_Outcome

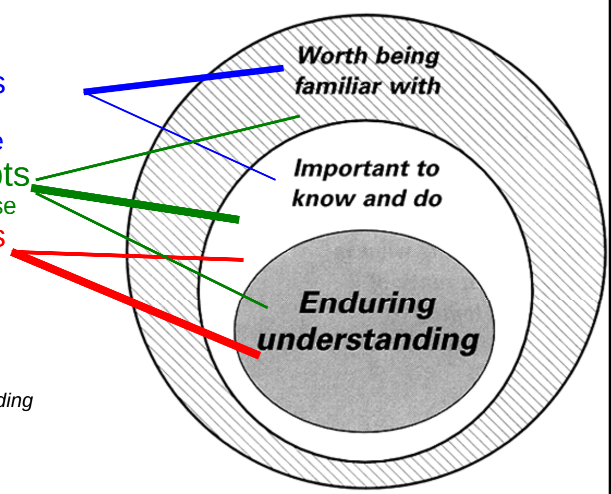
Teaching Teaching and Understanding Understanding

- Biggs SOLO taxonomy

- http://video.google.com/videoplay?docid=-5629273206953884671#

Curricular Priorities and Assessment Methods

- Assessment Types
  - Traditional quizzes and tests
    - Selected-response
  - Academic Prompts
    - Constructed-response
  - Performance tasks and projects
    - Open-ended
    - Complex
    - Authentic



McTighe & Wiggins (1999) *Understanding by design handbook.* ASCD.

Resources

- Design Framework – How People Learn (HPL) & Understanding by Design (UdB) Process
  - Ambrose, S., et.al. 2010. *How learning works: 7 research based principles for smart* teaching. Jossey-Bass
  - Bransford, John, Vye, Nancy, and Bateman, Helen. 2002. Creating High-Quality Learning Environments: Guidelines from Research on How People Learn. *The Knowledge Economy and Postsecondary Education: Report of a Workshop*. National Research Council. Committee on the Impact of the Changing Economy of the Education System. P.A. Graham and N.G. Stacey (Eds.). Center for Education. Washington, DC: National Academy Press. http://www.nap.edu/openbook/0309082927/html/
  - Pellegrino, J. 2006. 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.
  - Streveler, R.A., Smith, K.A. and Pilotte, M. 2012. Content, Assessment and Pedagogy (CAP): An Integrated Engineering Design Approach. In Dr. Khairiyah Mohd Yusof, Dr. Shahrin Mohammad, Dr. Naziha Ahmad Azli, Dr. Mohamed Noor Hassan, Dr. Azlina Kosnin and Dr. Sharifah Kamilah Syed Yusof (Eds.). *Outcome-Based Education and Engineering Curriculum: Evaluation, Assessment and Accreditation*, Universiti Teknologi Malaysia, Malaysia [Streveler-Smith-Pilotte_OBE_Chapter-CAP-v11.pdf]
  - Wiggins, G. & McTighe, J. 2005. *Understanding by Design: Expanded Second Edition*. Prentice Hall.
- 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
  - Cooperative Learning (Johnson, Johnson & Smith) - Smith web site – 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]
  - Johnson, Johnson & Smith. 1998. 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
  - 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