

# Design and Implementation of Cooperative Learning in Introductory Physics



**Karl A. Smith**

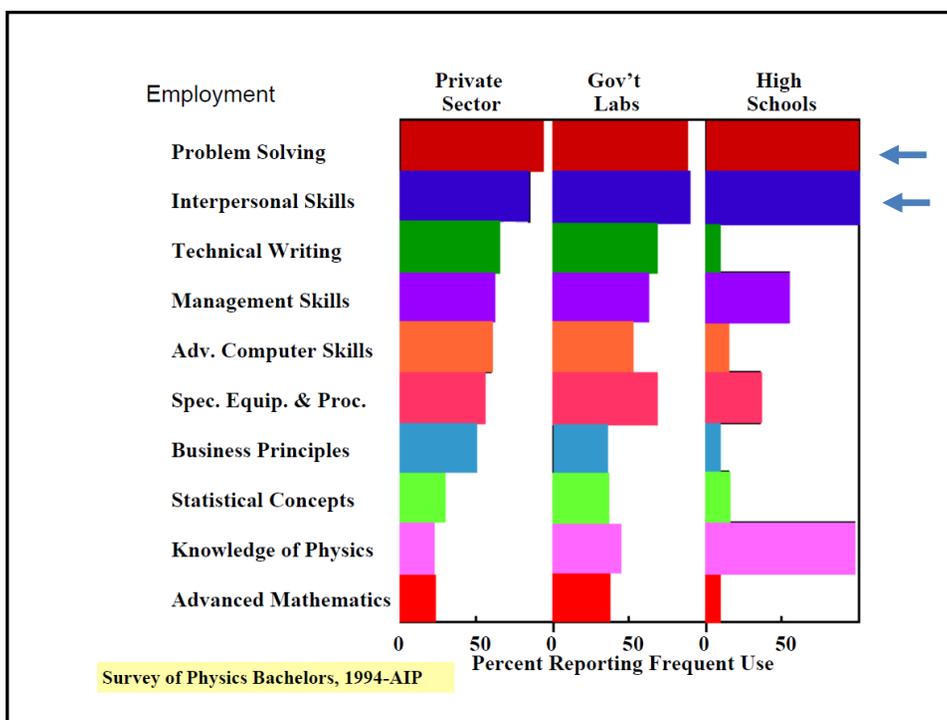
Civil Engineering/STEM Education Center –  
University of Minnesota &  
Engineering Education – Purdue University

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

<http://personal.cege.umn.edu/~smith/links.htm>

Physics Teaching Assistants Workshop

August 29, 2016



## Problem Solving *a la* Martinez

“Process of Moving Toward a Goal When Path is Uncertain.”

- If you know **how** to do it, it's **not** a problem.

(Exercise vs Problem)



“Problem Solving Involves **Error and Uncertainty**”

A problem for your students is not a problem for you.

M. Martinez, Phi Delta Kappan, April, 1998

It is strange that we expect students to learn, yet seldom teach them anything about learning. **We expect students to solve problems, yet seldom teaching them anything about problem solving.** And, similarly, we sometimes require students to remember A considerable body of material, yet seldom teach them the art of memory. It is time we Made up for this lack...

D.A. Norman. 1980. Cognitive engineering and education. In D.T. Tuma and F. Reif (Eds.), *Problem solving and education: Issues in teaching and research*. Erlbaum, pp. 97-107.

# Session Layout

---

Welcome & Overview

Cooperative Learning

- Description & Rationale
- Cooperative Learning
  - Key Concepts
  - Types of Cooperative Learning

Teamwork – High Performing Teams & Teamwork Skills

Implementing Cooperative Learning

- Practice
- Examples
- Applications

5

# Overall Goals

---

- Build your knowledge of Cooperative Learning and your implementation repertoire
- Implement practices to improve student learning, especially their problem solving skills

6

## Cooperative Learning Objectives

---

Participants will be able to list and describe essential features of the instructor's role in implementing cooperative learning

Participants will be able to elaborate on multiple ways Positive Interdependence and Individual Accountability were structured

Participants will identify features to implement in their own courses

7

## Karl's Introduction to Cooperative Learning

---

First Teaching Experience – Third-year course in metallurgical reactions – thermodynamics and kinetics

8

## Process Metallurgy

---

Dissolution Kinetics – liquid-solid interface

Iron Ore Desliming – solid-solid interface

Metal-oxide reduction roasting – gas-solid interface

## Dissolution Kinetics

---

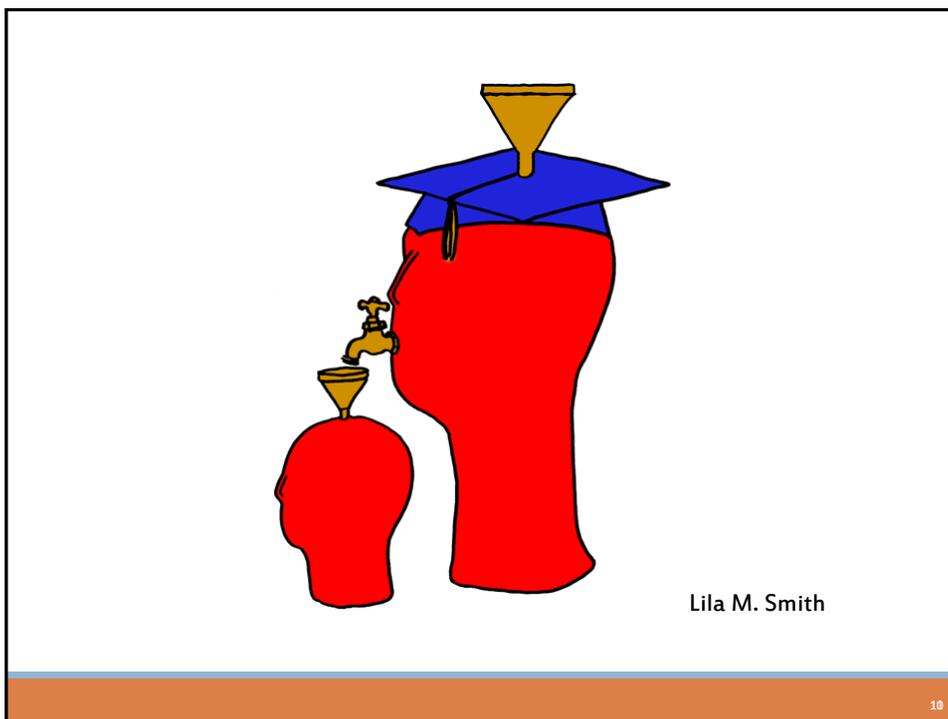
Theory – Governing  
Equation for Mass  
Transport

$$(\nabla c \bullet \underline{v}) = D \nabla^2 c$$

Research – rotating  
disk

$$v_y \frac{dc}{dy} = D \frac{d^2c}{dy^2}$$

Practice – leaching of  
silver bearing metallic  
copper and printed  
circuit board waste



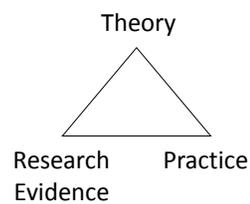
10

## Karl's Quandry

Practice – Third-year course in metallurgical reactions – thermodynamics and kinetics

Theory – ?

Research – ?

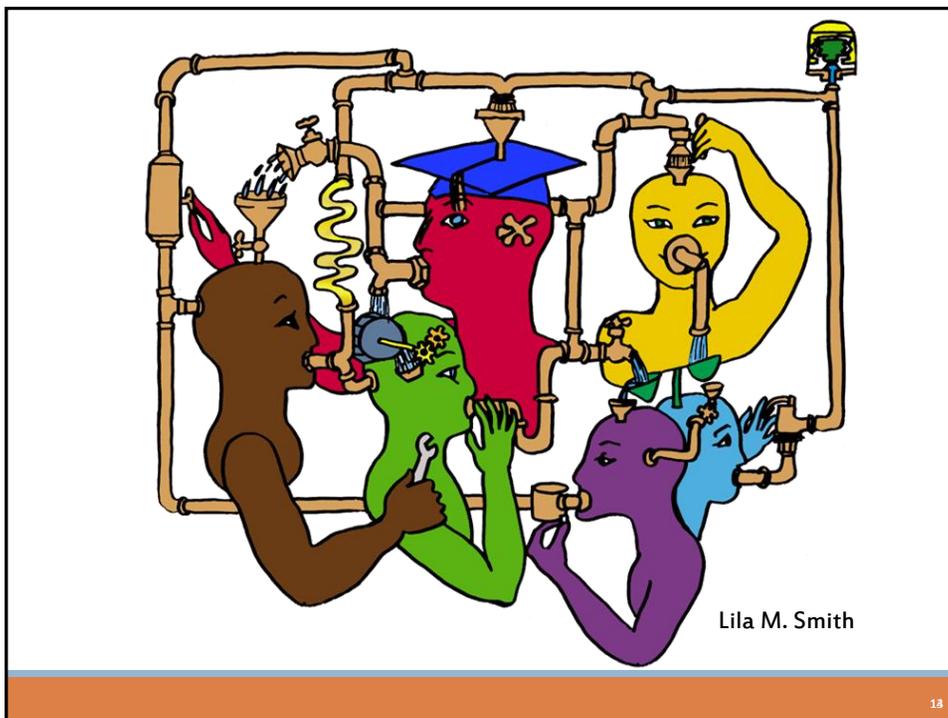


12

## University of Minnesota College of Education Social, Psychological and Philosophical Foundations of Education

- Statistics, Measurement, Research Methodology
- Assessment and Evaluation
- Learning and Cognitive Psychology
- Knowledge Acquisition, Artificial Intelligence, Expert Systems
- Development Theories
- Motivation Theories
- Social psychology of learning – student – student interaction

13



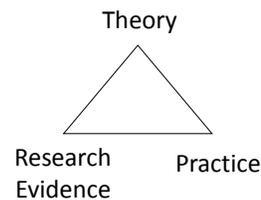
13

# Cooperative Learning

Theory – Social Interdependence – Lewin –  
Deutsch – Johnson & Johnson

Research – Randomized Design Field  
Experiments

Practice – Formal Teams/Professor's Role



15

**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://personal.cege.umn.edu/~smith/docs/Smith-CL%20Handout%2008.pdf>

**Cooperative Learning**

Positive Interdependence	Individual Accountability
<p><b>Goal Interdependence (essential)</b></p> <ol style="list-style-type: none"> <li>All members share equally</li> <li>All members improve</li> <li>Add group member scores to get overall group score</li> <li>One product from group that all helped with and are proud of</li> </ol> <p><b>Role (Chair) Interdependence</b> Assign each member a role and make them</p> <p><b>Resource Interdependence</b> Assign each member a role and make them</p> <ol style="list-style-type: none"> <li>Each member has a role</li> <li>Signer materials</li> <li>Separate contributions</li> </ol> <p><b>Task Interdependence</b></p> <ol style="list-style-type: none"> <li>Assign roles</li> <li>Chair Rotation</li> </ol> <p><b>Outside Challenge Interdependence</b></p> <ol style="list-style-type: none"> <li>Inter-group competition</li> <li>Other class competition</li> </ol> <p><b>Identity Interdependence</b> (Mutual identity issues, motto, etc.)</p> <p><b>Structural Interdependence</b></p> <ol style="list-style-type: none"> <li>Designated classroom space</li> <li>Classroom special meeting place</li> </ol> <p><b>Norms Interdependence</b> Physical interdependence in relation (Chair and a specific group group, sign on the walls, etc.)</p> <p><b>Reward/Challenge Interdependence</b></p> <ol style="list-style-type: none"> <li>Collaborate joint success</li> <li>Reward points and with class</li> <li>Single group grade (refer to all)</li> </ol>	<p><b>Ways to ensure no shirkers</b></p> <ul style="list-style-type: none"> <li>Assign group size (3-4)</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 assignment</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 role</li> <li>Randomly select work and sign agreement</li> <li>Randomly check one paper from each group</li> <li>Class individual tests</li> <li>Assign the role of <b>shaker</b> who has each group member explain the task</li> <li>Randomly assign 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>Class members close together</li> <li>Small group size of two or three</li> <li>Frequent and frequent</li> <li>Strong positive interdependence</li> <li>Commitment to each other's learning</li> <li>Positive social skill use</li> <li>Calculations for encouragement, effort, help, and success!</li> </ul> <p><b>Carl A. Smith</b> University of Minnesota, Duluth smith@uodh.edu http://www.cege.umn.edu/~smith Bloom, Minnesota</p>

# Cooperative Learning Introduced to Engineering – 1981

Smith, K.A., Johnson, D.W. and Johnson, R.T., 1981. The use of cooperative learning groups in engineering education. In L.P. Grayson and J.M. Biedenbach (Eds.), *Proceedings Eleventh Annual Frontiers in Education Conference*, Rapid City, SD, Washington: IEEE/ASEE, 26-32.

## Structuring Learning Goals To Meet the Goals of Engineering Education

Karl A. Smith, David W. Johnson, and Roger T. Johnson  
Universities of Minnesota

The growing concern about engineering education in the United States has led to the adoption of many reform efforts and studies. They point to the desirability of engineering and science education, the lack of adequate preparation in mathematics and science as the part of high school graduates, the shortage of engineers, and, especially, the shortage of college graduates of engineering. While various reform efforts are taken, it may be more difficult to convince those who believe the goals of engineering education and to meet the needs of engineering students.

### Goals of Engineering Education

The three major goals of engineering education are to produce technically competent, innovative, and socially responsible engineers. The attainment of technological competence requires the student and teacher of science and engineering to understand the relationship of scientific, design, manufacturing and problem solving skills, and

\*This is a revised version of "Engineering Education in the United States and Europe," *Journal of Engineering Education*, 70, 7, March, pp. 305, in 1981.

the interaction between science and technology.

### Needs of Engineering Graduates

Many studies have been conducted on engineering education since it began at West Point in 1775, and there have been well-documented. The earliest study by Mason in 1810 called for a stress on the basics, such as the subsequent one mentioned disparity and a broad education, and that general engineering has been recommended by Clark in the following three decades.

1. There is a general consensus that, despite many efforts, engineering education is not yet increasing what is called the "humanistic component," or general parts of the student education.

2. Engineering education must be more socially oriented, and it must meet social needs for the development of the student of science and behavioral perspectives in the working world to perform a task.

3. Engineers must be made aware of the importance of engineering to American life, engineers have an ethical management, interpersonal, problem solving, and business writing and presentation skills. Interpersonal competence is becoming increasingly important for engineers due to the increasing technical complexity and the social constraints of most problems. Engineers must now, more than ever, work with other engineers and scientists, scientists, education, consumer groups, and government regulatory agencies.

The understanding of these studies are valuable resources, but the need for change in engineering education remains. Currently, there appears to be a direct away from the image of applied science in engineering education. The focus of the report change is the growing realization that technological and economic feasibility are not the sole or even the main determinants of change.

The results of the major studies of engineering education are to identify with the need for increasing social-behavioral competence and, therefore, general competence in engineering graduates. Supporting this need, a study conducted at the University of California, Los Angeles, concluded that most engineering graduates must be capable of communicating with and working with people of other professions to solve the issues of the basic process understanding

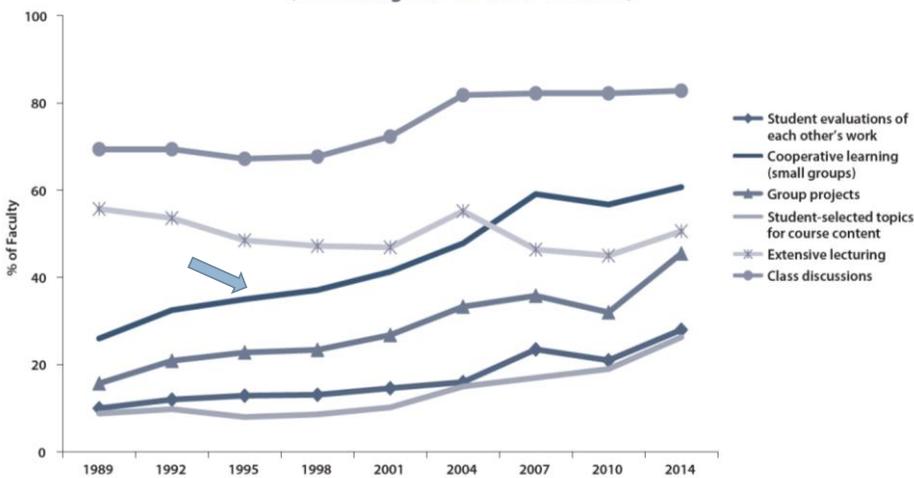
JEE December 1981

PROCEEDINGS EDUCATION December 1981 / 331

[http://personal.cege.umn.edu/~smith/docs/Smith-Pedagogies\\_of\\_Engagement.pdf](http://personal.cege.umn.edu/~smith/docs/Smith-Pedagogies_of_Engagement.pdf)

## Undergraduate Teaching Faculty: The 2013–2014 HERI Faculty Survey

Figure 2. Changes in Faculty Teaching Practices, 1989 to 2014 (% Marking "All" or "Most" Courses)



<http://heri.ucla.edu/monographs/HERI-FAC2014-monograph.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

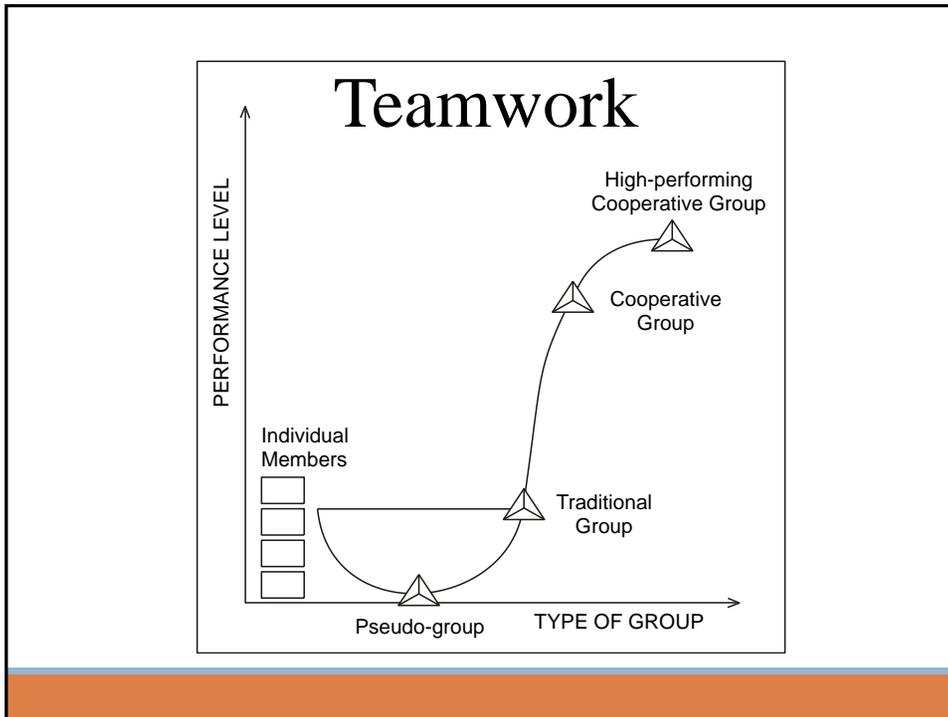
Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching*, 25(3&4)

19

## Structuring Teamwork in the Classroom



### Formal Cooperative Learning Task Groups



## Reflection and Dialogue

Individually reflect on the Characteristics of High Performing Teams. Think/Write for about 1 minute

- Base on your experience on high performing teams,
- Or your facilitation of high performing teams in your classes,
- Or your imagination

Discuss with your team for about 2 minutes and record a list

## Characteristics of High Performing Teams

---

- ?
- ?

A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable:

- SMALL NUMBER
- COMPLEMENTARY SKILLS
- COMMON PURPOSE & PERFORMANCE GOALS
- COMMON APPROACH
- MUTUAL ACCOUNTABILITY

--Katzenbach & Smith (1993)

*The Wisdom of Teams*

**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://personal.cege.umn.edu/~smith/docs/Smith-CL%20Handout%2008.pdf>

Cooperative Learning	
Positive Interdependence	Individual Accountability
<p><b>Goal Interdependence essential!</b></p> <ol style="list-style-type: none"> <li>All members share equally</li> <li>All members improve</li> <li>All group members receive to get successful group score</li> <li>One person from group that all helped with and can explain</li> </ol> <p><b>Role (Choir) Interdependence</b> Assign each member a role and make them</p> <p><b>Resource Interdependence</b></p> <ol style="list-style-type: none"> <li>Limit resource use out of materials</li> <li>Signer materials</li> <li>Separate contributions</li> </ol> <p><b>Task Interdependence</b></p> <ol style="list-style-type: none"> <li>Randomizer</li> <li>Chain Reaction</li> </ol> <p><b>Identity Challenge Interdependence</b></p> <ol style="list-style-type: none"> <li>Intergroup competition</li> <li>Other class competition</li> </ol> <p><b>Mutual Interdependence</b> (Mutual identity, names, motto, etc.)</p> <p><b>Structural Interdependence</b></p> <ol style="list-style-type: none"> <li>Designated classroom space</li> <li>Conduct special meetings there</li> </ol> <p><b>Norms Interdependence</b> Interpersonal interdependence or situation ("Who are a benefit/impact prior task, later, later, etc.")</p> <p><b>Reward/Collaboration Interdependence</b></p> <ol style="list-style-type: none"> <li>Collaborate joint success</li> <li>Reward points use with Level</li> <li>Single group grade (refer list to all)</li> </ol>	<p><b>Ways to ensure no shirkers</b></p> <ul style="list-style-type: none"> <li>Assign group size (not 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 see 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>Ask each when work and sign agreement</li> <li>Randomly check one paper from each group</li> <li>Class individual tests</li> <li>Assign the role of shirker who has each group member explain and lead</li> <li>Nonresponse 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>Consign materials close together</li> <li>Small group size of two or three</li> <li>Frequent and informal</li> <li>Strong positive interdependence</li> <li>Commitment to each other's learning</li> <li>Positive social skill use</li> <li>Calculations for encouragement, effort, help, and success</li> </ul>

**Carl A. Smith**  
University of Minnesota Duluth  
carlsmith@uaduluth.edu  
http://www.cege.umn.edu/~smith  
Rice Institute

## Six Basic Principles of Team Discipline

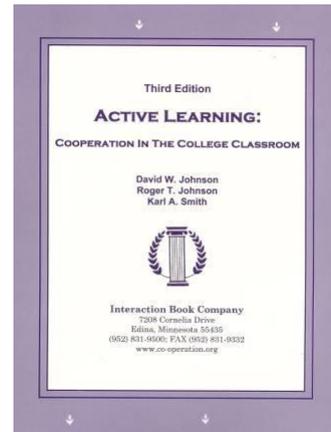
- Keep membership small
- Ensure that members have complimentary skills
- Develop a common purpose
- Set common goals
- Establish a commonly agreed upon working approach
- Integrate mutual and individual accountability

Katzenbach & Smith (2001) *The Discipline of Teams*

## Active Learning: Cooperation in the College Classroom

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

**Notes: Cooperative Learning Handout (CL-College-814.doc)**  
[\[CL-College-814.doc\]](#)



## Instructor's Role in Formal Cooperative Learning

1. Specifying **Objectives** (Academic and Interpersonal/Teamwork)
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

## Cooperative Problem-Based Learning Format

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

**INDIVIDUAL:** Develop ideas, Initial Model, Estimate, etc. 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 model and 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.

## *Building Models to Solve Engineering Problems* – UMN – Institute of Technology course (~1978 – 2000)

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



## Team Member Roles

---

- Task Recorder
- Skeptic/Prober
- Process Recorder

39

## Technical Estimation Problem

---

**TASK:**

**INDIVIDUAL:** Quick Estimate (10 seconds). Note strategy.  
Note strategy.

**COOPERATIVE:** Improved Estimate (~5 minutes). One set of answers from the group, strive for agreement, make sure everyone is able to explain the strategies used to arrive at the improved estimate.

**EXPECTED CRITERIA FOR SUCCESS:**  
Everyone must be able to explain the strategies used to arrive at your improved estimate.

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

**INDIVIDUAL ACCOUNTABILITY:** One member from your group may be randomly chosen to explain (a) your estimate and (b) how you arrived at it.

**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.

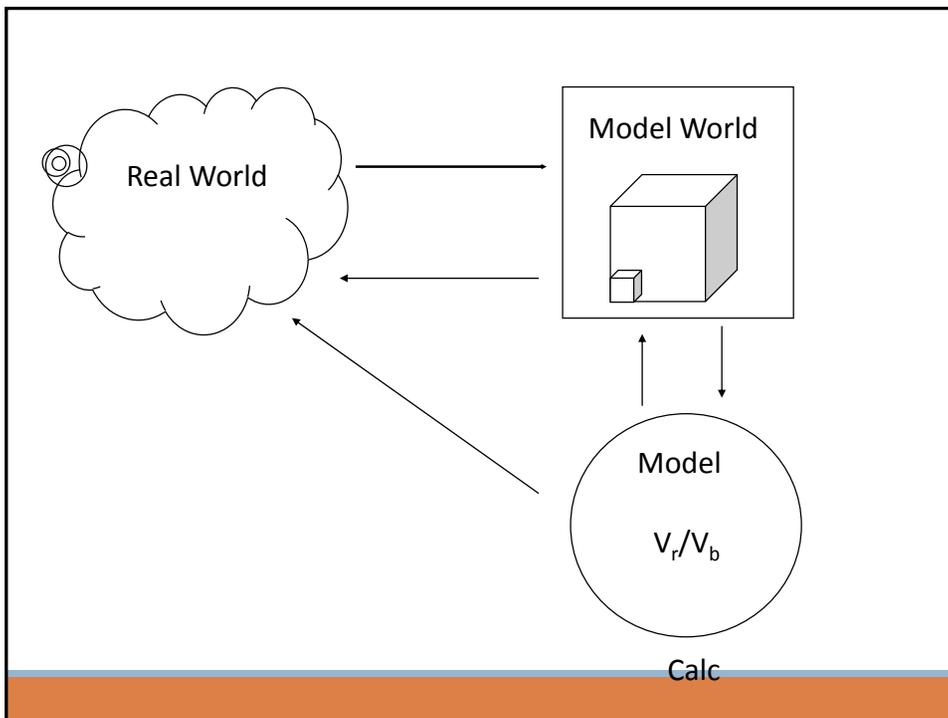
# Group Reports

---

## Estimate

- Group 1
- Group 2
- ...

Strategy used to arrive at estimate – assumptions, model, method, etc.



## Modeling

Modeling in its broadest sense is the cost-effective use of something in place of something else for some cognitive purpose (Rothenberg, 1989). A model represents reality for the given purpose; the model is an abstraction of reality in the sense that it cannot represent all aspects of reality.

Any model is characterized by three essential attributes: (1) *Reference*: It is of something (its "referent"); (2) *Purpose*: It has an intended cognitive *purpose* with respect to its referent; (3) *Cost-effectiveness*: It is more *cost-effective* to use the model for this purpose than to use the referent itself.

Rothenberg, J. 1989. The nature of modeling. In L.E. Widman, K.A. Laparo & N.R. Nielson, Eds., *Artificial intelligence, simulation and modeling*. New York: Wiley

## Modeling Heuristics

Ravindran, Phillips, and Solberg (1987):

1. **Do not build a complicated model when a simple one will suffice.**
2. Beware of molding the problem to fit the technique.
3. The deduction phase of modeling must be conducted rigorously.
4. Models should be validated prior to implementation.
5. A model should never be taken too literally.
6. A model should neither be pressed to do, nor criticized for failing to do, that for which it was never intended.
7. Beware of overselling a model.
8. **Some of the primary benefits of modeling are associated with the process of developing the model.**
9. **A model cannot be any better than the information that goes into it.**
10. Models cannot replace decision makers.

## Heuristics - Koen

An essential aspect of modeling is the use of heuristics. Although difficult to define, heuristics are relatively easy to identify using the characteristics listed by Koen(1984): (1) Heuristics do not guarantee a solution; (2) Two heuristics may contradict or give different answers to the same question and still be useful; (3) Heuristics permit the solving of unsolvable problems or reduce the search time to a satisfactory solution; (4) The heuristic depends on the immediate context instead of absolute truth as a standard of validity. A heuristic is anything that provides a plausible aid or direction in the solution of a problem but is in the final analysis unjustified, incapable of justification, and fallible. It is used to guide, to discover, and to reveal.

Koen, Billy V. 1984. *Definition of the engineering method*. Washington, DC: ASEE.

Heuristics are also a key part of the Koen's definition of the engineering method: ***The engineering method is the use of heuristics to cause the best change in a poorly understood situation within the available resources*** (p. 70). Typical engineering heuristics include:

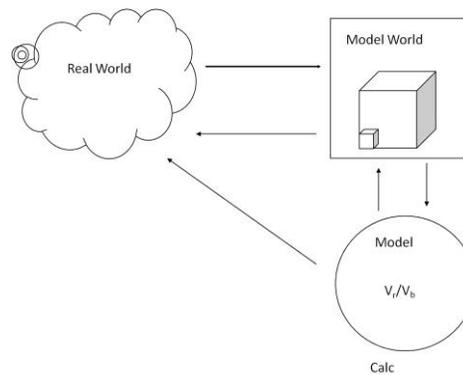
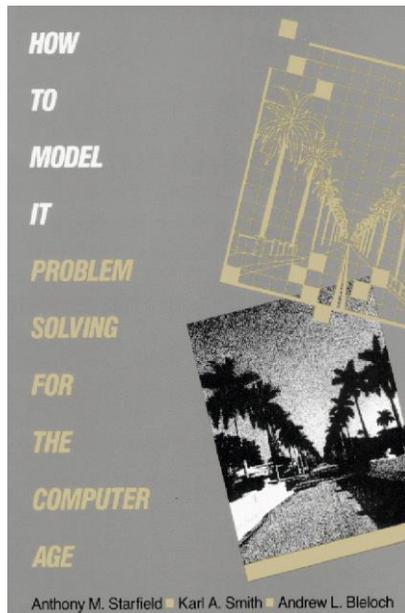
- (1) Rules of thumb and orders of magnitude;
- (2) Factors of safety;
- (3) Heuristics that determine the engineer's attitude toward his or her work;
- (4) Heuristics that engineers use to keep risk within acceptable bounds; and
- (5) Rules of thumb that are important in resource allocation.

# Group Processing Plus/Delta Format

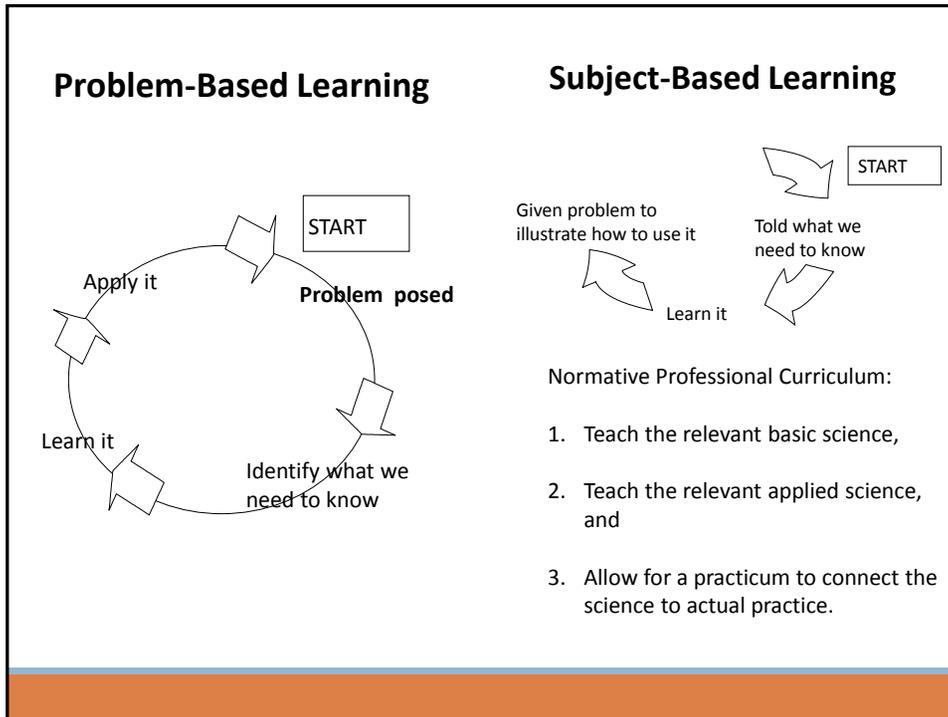
Plus (+)  
Things That Group Did Well

Delta ( $\Delta$ )  
Things Group Could Improve

Plus (+) Things That Group Did Well	Delta ( $\Delta$ ) Things Group Could Improve



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



**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://personal.cege.umn.edu/~smith/docs/Smith-CL%20Handout%2008.pdf>

Cooperative Learning	
Positive Interdependence	Individual Accountability
<b>Goal Interdependence (essential)</b> 1. All members share resources 2. All members improve 3. Add group member scores to get overall group score 4. One product from group that all helped with and are proud of	<b>Ways to ensure no shirkers</b> • Hold 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 assignment • Everyone signs "I participated, I agree, and I am helpful" • Observe & record individual contributions
<b>Role (Chit) Interdependence</b> Assign each member a role and make them:	<b>Ways to ensure that all members learn</b> • Practice tests • Rotate each other's work and sign agreement • Randomly check one paper from each group • Give individual tests • Assign the role of <b>shaker</b> who has each group member explain her/his • Randomly assign each student explains their learning to a new partner
<b>Resource Interdependence</b> 1. Each receives one set of materials 2. Signer materials 3. Separate contributions	<b>Face-to-Face Interaction</b> • Promote • Time for groups to meet • Class members close together • Small group size of two or three • Frequent and helpful • Being positive interdependence • Commitment to each other's learning • Positive social skill use • Collaborative for encouragement, effort, help, and success!
<b>Task Interdependence</b> 1. Assign roles 2. Check frequently 3. Check frequently	
<b>Outcome/Challenge Interdependence</b> 1. Interlocking contributions 2. Other class competition <b>Identify Interdependence</b> (Mutual identity, teams, units, etc.) <b>Structural Interdependence</b> 1. Designated classroom space 2. Create the special meeting place <b>Norms Interdependence</b> Physiological interdependence in situation (Play one a specific/strong group task, sign on the norms, etc.) <b>Reward/Challenge Interdependence</b> 1. Collaborate joint success 2. Bonus points and extra credit 3. Single group grade (refer to all)	
<b>Carl A. Smith</b> University of Minnesota, Duluth carlsmith@uod.edu http://www.cege.umn.edu/~smith Home: 612-921-3111	

## Instructor's Role in Formal Cooperative Learning

---

1. Specifying **Objectives** (Academic and Social/Teamwork)
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

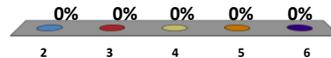
## Decisions, Decisions...

---

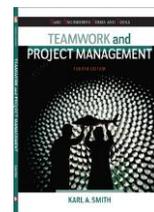
- Group size?
- Group selection?
- Group member roles?
- How long to leave groups together?
- Arranging the room?
- Providing materials?
- Time allocation?

## Optimal Group Size?

- A. 2
- B. 3
- C. 4
- D. 5
- E. 6

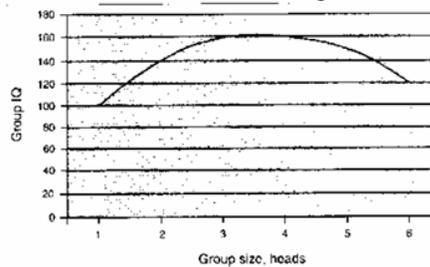


## Formal Cooperative Learning Task Groups



Page 48

Perkins, David. 2003. *King Arthur's Round Table: How collaborative conversations create smart organizations*. NY: Wiley.



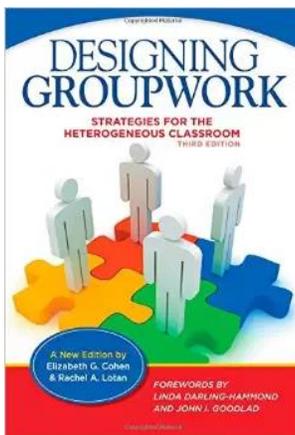
## Group Selection?

---

- A. Self selection
- B. Random selection
- C. Stratified random
- D. Instructor assign
- E. Other

## Assigning Roles

---

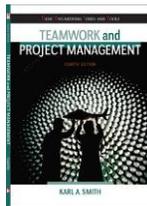


### Chapter 8: Group Roles and Responsibilities

- Roles
  - Facilitator
  - Checker
  - Set-Up
  - Materials Manager
  - Safety Officer
  - Reporter
- Dividing the labor

# Teamwork Skills

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



Chapters 3, 4, 5 & 6

Cooperative Teamwork Skills	Teaching Cooperative Skills
<p><b>Forming Skills</b> Initial Management Skills</p> <ul style="list-style-type: none"> <li>• Move Into Groups Quietly</li> <li>• Stay With the Group</li> <li>• Use Quiet Voices</li> <li>• Take Turns</li> <li>• Use Names, Look at Speaker</li> <li>• No "Put-Downs"</li> </ul> <p><b>Functioning Skills</b> Group Management Skills</p> <ul style="list-style-type: none"> <li>• Share Ideas and Opinions</li> <li>• Ask for Facts and Reasoning</li> <li>• Give Direction to the Group's Work (state assignment purpose, provide time limits, offer procedures)</li> <li>• Encourage Everyone to Participate</li> <li>• Ask for Help or Clarification</li> <li>• Express Support and Acceptance</li> <li>• Offer to Explain or Clarify</li> <li>• Paraphrase Other's Contributions</li> <li>• Energize the Group</li> <li>• Describe Feelings When Appropriate</li> </ul> <p><b>Formulating Skills</b> Formal Methods for Processing Materials</p> <ul style="list-style-type: none"> <li>• Summarize Out Loud Completely</li> <li>• Seek Accuracy by Correcting/Adding to Summaries</li> <li>• Help the Group Find Clever Ways to Remember</li> <li>• Check Understanding by Demanding Vocalization</li> <li>• Ask Others to Plan for Selling/Teaching Out Loud</li> </ul> <p><b>Forming Skills</b> Simulate Cooperative Conflict and Reasoning</p> <ul style="list-style-type: none"> <li>• Criticize Ideas Without Criticizing People</li> <li>• Differentiate Ideas and Reasoning of Members</li> <li>• Integrate Ideas into Single Positions</li> <li>• Ask for Justification on Conclusions</li> <li>• Expect Answers</li> <li>• Probe by Asking In-depth Questions</li> <li>• Generate Further Answers</li> <li>• Test Reality by Checking the Group's Work</li> </ul>	<ol style="list-style-type: none"> <li>1. Help students see the <b>need</b> to learn the skill.</li> <li>2. Help them <b>know how</b> to do it (T-chart).</li> <li>3. Encourage them to <b>practice</b> the skill daily.</li> <li>4. Help them <b>reflect on</b> process, &amp; refine use.</li> <li>5. Help them <b>persevere</b> until skill is automatic.</li> </ol> <p><b>Monitoring, Observing, Intervening, and Processing</b></p> <p><b>Monitor</b> to promote academic &amp; cooperative success</p> <p><b>Observe</b> for appropriate teamwork skills: praise their use and remind students to use them if necessary</p> <p><b>Intervene</b> if necessary to help groups solve academic or teamwork problems.</p> <p><b>Process</b> so students continuously analyze how well they learned and cooperated in order to continue successful strategies and improve when needed</p> <p><b>Ways of Processing</b></p> <p><b>Positive Feedback:</b></p> <ol style="list-style-type: none"> <li>1. Have volunteer students tell the class something their partners did which helped them learn today.</li> <li>2. Have all students tell their partners something the partners did which helped them learn today.</li> <li>3. Tell the class helpful behaviors you saw today.</li> </ol> <p><b>Group Analysis:</b></p> <ol style="list-style-type: none"> <li>1. Name 3 things your group did today which helped you learn and work well together.</li> <li>2. Name 1 thing you could do even better next time.</li> </ol> <p><b>Cooperative Skill Analysis:</b></p> <ol style="list-style-type: none"> <li>1. Rate your use of the target cooperative skill: Great / Pretty Good / Needs work</li> <li>2. Decide how you will encourage each other to practice the target skill next time.</li> </ol> <p><b>Start:</b> "Tell your partners you're glad they're here."</p> <p><b>End:</b> "Tell your partners you're glad they were here today! Thank them for helping."</p>
<p>Interaction Book Company 5028 Hall Ave. S. Gilroy, CA 95024 (952)831-9500 Fax (952)831-9332 www.co-operation.org</p>	<p>REFERENCES K.A. Smith, S.D. Sheppard, D.W. Johnson, &amp; T. Johnson, 2005, Techniques of engagement: Classroom-based practice, Journal of Engineering Education, 94(1), 45-52. D.W. Johnson, &amp; K.A. Smith, 2006, Active Learning: Cooperation in the College Classroom, 3rd Ed., Boston, MA: Interaction Book Company.</p>

## TEAMWORK

## Teaching Cooperative Skills

1. Help students see the **need** to learn the skill.
2. Help them **know how** to do it (T-chart).
3. Encourage them to **practice** the skill daily.
4. Help them **reflect on**, process, & refine use.
5. Help them **persevere** until skill is automatic

### Monitoring, Observing, Intervening, and Processing

**Monitor** to promote academic & cooperative success

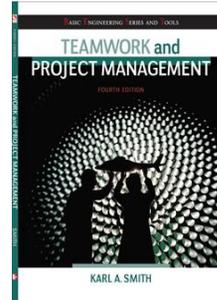
**Observe** for appropriate teamwork skills: praise their use and remind students to use them if necessary

**Intervene** if necessary to help groups solve academic or teamwork problems.

**Process** so students continuously analyze how well they learned and cooperated in order to continue successful strategies and improve when needed

# Team Charter

- Team name, membership, and roles
- Team mission
- Anticipated results (goal)
- Specific tactical objectives
- Ground rules/ Guiding principles for team participation**
- Shared expectations/aspirations



pp. 60-61, 204-205

## Group Ground Rules Contract Form

(Adapted from a form developed by Dr. Deborah Allen, University of Delaware)

Project groups are an effective aid to learning, but to work best they require that all groups members clearly understand their responsibilities to one another. These project group ground rules describe the general responsibilities of every member to the group. You can adopt additional ground rules if your group believes they are needed. Your signature on this contract form signifies your commitment to adhere to these rules and expectations.

All group members agree to:

1. Come to class and team meetings on time.
2. Come to class and team meetings with assignments and other necessary preparations done.

Additional ground rules:

- 1.
- 2.

If a member of the project team repeatedly fails to meet these ground rules, other members of the group are expected to take the following actions:

Step 1: (fill in this step with your group)

If not resolved:

Step 2: Bring the issue to the attention of the teaching team.

If not resolved:

Step 3: Meet as a group with the teaching team.

The teaching team reserves the right to make the final decisions to resolve difficulties that arise within the groups. Before this becomes necessary, the team should try to find a fair and equitable solution to the problem.

Member's Signatures: \_\_\_\_\_ Group Number: \_\_\_\_\_

1. \_\_\_\_\_ 3. \_\_\_\_\_  
2. \_\_\_\_\_ 4. \_\_\_\_\_

## Reflection and Dialogue

---

Individually reflect on **rationale** for Teamwork and Cooperative Learning. Write for about 1 minute.

- Context/Audience – Introductory Physics course
- Why cooperative learning and teamwork are important?
- What support do you have for your rationale?

Discuss with your neighbor for about 2 minutes

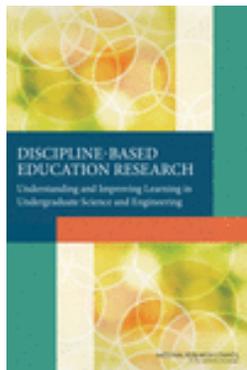
- Select/create a response to present to the whole group if you are randomly selected

71

## Why Emphasize Cooperative Learning and Teamwork?

- Student learning
- Essential **transferrable skill** development
- Key to **innovation**
- High priority for **Employers**

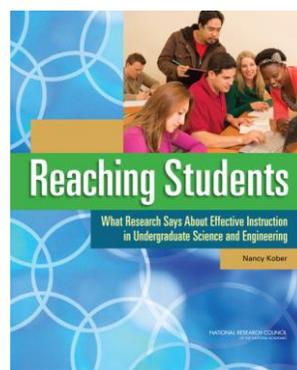
# Discipline-Based Education Research (DBER) Report



National Research Council  
Summer 2012 –  
[http://www.nap.edu/catalog.php?record\\_id=13362](http://www.nap.edu/catalog.php?record_id=13362)



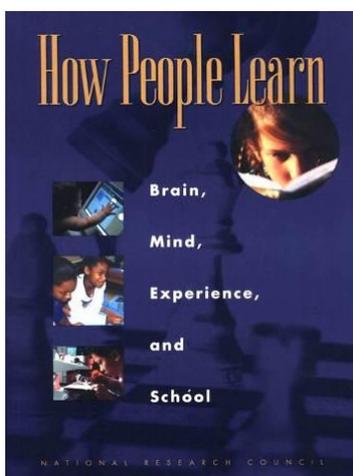
ASEE Prism Summer 2013  
*Journal of Engineering Education* – October, 2013



National Research Council – 2015  
<http://www.nap.edu/catalog/18687/reaching-students-what-research-says-about-effective-instruction-in-undergraduate>

73

## Expertise Implies:



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<sup>74</sup>. 1999. *How people learn*. National Academy Press.

## Acquisition of Expertise

Fitts P, & Posner MI. Human Performance. Belmont, CA: Brooks/Cole, 1967.

---

Cognition: Learn from instruction or observation what knowledge and actions are appropriate

Associative: Practice (with feedback) allowing smooth and accurate performance

Automaticity: "Compilation" or performance and associative sequences so that they can be done without large amounts of cognitive resources

"The secret of expertise is that there is no secret. It takes at least 10 years of concentrated effort to develop expertise." Herbert Simon

## Learning Requires

---

deliberate

distributed

practice

## Key Implications

---

### Deliberate

*Attention must be paid*

Attention and processing power = cognitive load (bandwidth)

- LIMITED – need to be careful how one uses the learner’s bandwidth
  - Link to Curricular Priorities
- Continuous partial attention
- Reflection is needed
  - Need for feedback
  - Link to assessment

77

## Key Implications

---

### Distributed

Repetition over time

- Spaced vs. massed practice\*
- Spiral curriculum

Multiple modes of input

- Visual
- Audio
- Kinesthetic
- Self-explanation
- Explaining to others

\*Kandel, E.B. 2007. In Search of Memory: The Emergence of a New Science of Mind. New York: Norton.

78

## Key Implications

---

### **Practice** what you want to learn

Active – doing something

Constructive – adding to your prior knowledge

Interactive – working with others to add to your prior knowledge

Chi, M.T.H. 2009. Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities. *Topics in Cognitive Science 1*, 73–105.

79

## Cognitive apprenticeship (1 of 3)

---

1. Authentic tasks/situations
2. Narrated modeling
  - Challenges of this approach
    - Expert not used to explaining thinking
    - Expert forgets what is it like to be learning the material, “expert blind spot”
    - Subconscious or intuitive knowledge - “mystery of expert judgment”

80

## Cognitive apprenticeship (2 of 3)

---

3. Scaffolded and coached practice
  - Scaffold from learner's prior knowledge to new info
  - Coach can diagnose "problems" and correct
  - Immediate feedback – important for motivation
  - Informational feedback

81

## Cognitive apprenticeship (3 of 3)

---

3. Articulation of the steps by the learner
  - Self-explanation
4. Reflection on the process by the learner
  - Consolidates the skill, improves retention

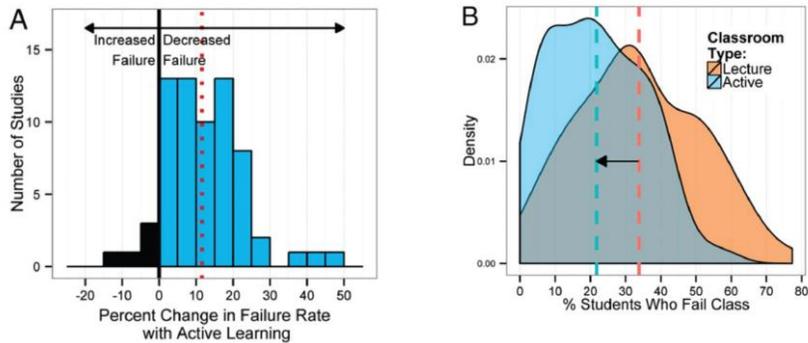
Collins, A., Brown, J. S., & Newman, S. E. (1987). Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics (Technical Report No. 403). BBN Laboratories, Cambridge, MA.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18, 32-42.

82

## Engaged Pedagogies = Reduced Failure Rates

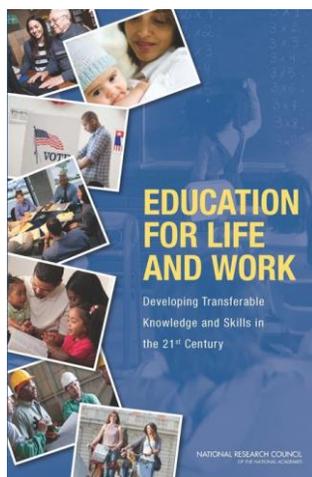
Evidence-based research on learning indicates that when students are actively involved in their education they are more successful and less likely to fail. A new PNAS report by Freeman et al., shows a significant decrease of failure rate in active learning classroom compared to traditional lecture



Freeman, Scott; Eddy, Sarah L.; McDonough, Miles; Smith, Michelle K.; Okoroafor, Nnadozie; Jordt, Hannah; Wenderoth, Mary Pat; Active learning increases student performance in science, engineering, and mathematics, 2014, Proc. Natl. Acad. Sci.

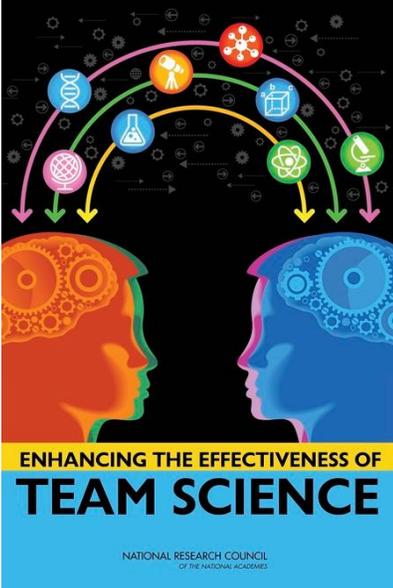
83

## Education for Life and Work



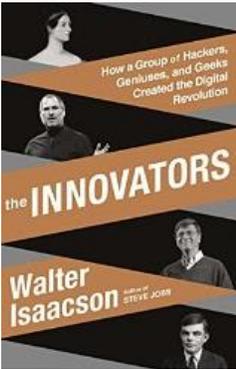
1. Introduction 15
2. A Preliminary Classification of Skills and Abilities 21
3. Importance of Deeper Learning and 21st Century Skills 37
4. Perspectives on Deeper Learning 69
5. Deeper Learning of English Language Arts, Mathematics, and Science 101
6. Teaching and Assessing for Transfer 143
7. Systems to Support Deeper Learning 185

<http://www.nap.edu/catalog/13398/education-for-life-and-work-developing-transferable-knowledge-and-skills>



**Conclusion.** A strong body of research conducted over several decades has demonstrated that **team processes** (e.g., shared understanding of team goals and member roles, conflict) **are related to team effectiveness**. Actions and interventions that foster positive team processes offer the most promising route to enhance team effectiveness; they target three aspects of a team: team composition (assembling the right individuals), team professional development, and team leadership. (p. 7)

<http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science>



This is the story of these pioneers, hackers, inventors, and entrepreneurs – who they were, how their minds worked, and what made them so creative. It’s also a narrative of **how they collaborated and why their ability to work as teams made them even *more* creative**. The tale of their teamwork is important because we don’t often focus on how central that skill is to innovation.



**Falling Short?  
College Learning and Career Success**

Selected Findings from Online Surveys of  
Employers and College Students  
Conducted on Behalf of  
the Association of American Colleges & Universities

By Hart Research Associates

Embargoed Until January 20, 2015, 12:01 a.m.

**Learning Outcomes Four in Five Employers Rate as Very Important  
(Proportion of employers who rate each outcome  
an 8, 9, or 10 on a zero-to-10 scale)**

	<u>Employers</u> %
The ability to effectively communicate orally	85
The ability to work effectively with others in teams	83
The ability to effectively communicate in writing	82
Ethical judgment and decision-making	81
Critical thinking and analytical reasoning skills	81
The ability to apply knowledge and skills to real-world settings	80

<http://www.aacu.org/leap/public-opinion-research/2015-survey-results>

**How Should Colleges Prepare  
Students To Succeed In  
Today's Global Economy?**

Conducted On Behalf Of:  
The Association Of American Colleges And Universities

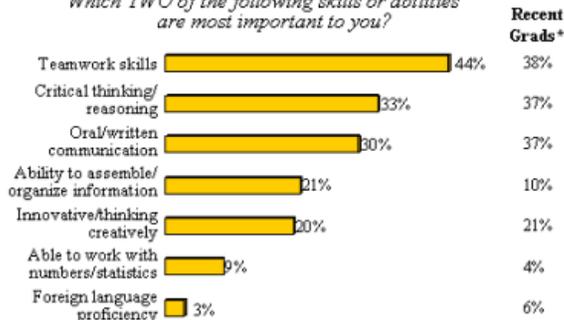
By Peter D. Hart Research Associates, Inc.

Based On Surveys Among  
Employers And Recent College Graduates

December 28, 2006

**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>

## The College Degrees And Skills Employers Most Want In 2015 (National Association of Colleges and Employers (NACE))

The NACE survey also asked employers to rate **the skills they most value in new hires**. Companies want candidates who can think critically, solve problems, work in a team, maintain a professional demeanor and demonstrate a strong work ethic. Here is the ranking in order of importance:

Competency	Essential Need Rating*
Critical Thinking/Problem Solving	4.7
Teamwork	4.6
Professionalism/Work Ethic	4.5
Oral/Written Communications	4.4
Information Technology Application	3.9
Leadership	3.9
Career Management	3.6

\*Weighted average. Based on a 5-point scale where 1=Not essential, 2=Not very essential; 3=Somewhat essential; 4=Essential; 5=Absolutely essential

<http://www.forbes.com/sites/susanadams/2015/04/15/the-college-degrees-and-skills-employers-most-want-in-2015/>

## Top Three Main Engineering Work Activities

### Engineering Total

Design – 36%

Computer applications – 31%

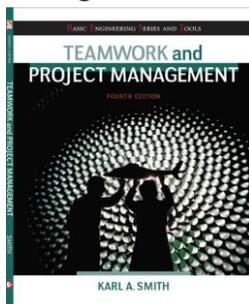
Management – 29%

### 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.

# 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 Role:** 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 promotes 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, restate) 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 on, done things they will do better tomorrow. Summarize as a whole class. Have groups celebrate their success and hard work.

<b>Cooperative Lesson Planning Form</b>	
Subject Area: _____ Date: _____	
Lesson: _____	
<b>Objectives</b>	
Academic: _____	
Social Skills: _____	
<b>Preinstructional Decisions</b>	
Group Size: _____ Method Of Assigning Students: _____	
Roles: _____	
Room Arrangement: _____	
Materials: _____	
<input type="checkbox"/> One Copy Per Group <input type="checkbox"/> One Copy Per Person <input type="checkbox"/> Jigsaw <input type="checkbox"/> Tournament <input type="checkbox"/> Other: _____	
<b>Explain Task And Cooperative Goal Structure</b>	
1. Task: _____	
2. Criteria For Success: _____	
3. Positive Interdependence: _____	
4. Individual Accountability: _____	
5. Intergroup Cooperation: _____	
6. Expected Behaviors: _____	
<b>Monitoring And Intervening</b>	
1. Observation Procedure: _____ Formal _____ Informal	
2. Observation By: _____ Teacher _____ Students _____ Visitors	
3. Intervening For Task Assistance: _____	
4. Intervening For Teamwork Assistance: _____	
5. Other: _____	
<b>Evaluating And Processing</b>	
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: _____	

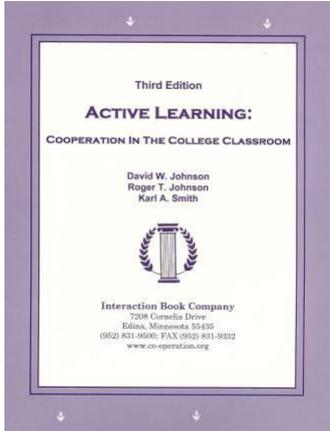
## Active Learning: Cooperation in the College Classroom

---

➔ **Informal** Cooperative Learning Groups

**Formal** Cooperative Learning Groups

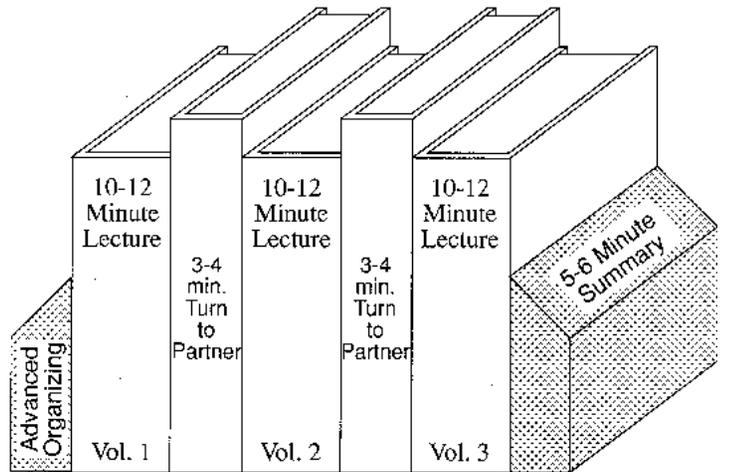
Cooperative **Base** Groups



**Notes: Cooperative Learning Handout (CL-College-814.doc)**  
[\[CL-College-814.doc\]](#)

94

## 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]

95

## 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

96

Informal Cooperative Learning Planning Form	COGNITIVE REHEARSAL QUESTIONS
<b>DESCRIPTION OF THE LECTURE</b>	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 <b>formulate, share, listen, and create</b> procedure.
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 <b>formulate, share, listen, create</b> procedure): _____	
<b>ADVANCED ORGANIZER QUESTION(S)</b>	<b>SUMMARY QUESTION(S)</b>
Questions should be aimed at promoting <b>advance organizing</b> of what the students know about the topic to be presented and <b>establishing expectations</b> as to what the lecture will cover. 1. _____ 2. _____ 3. _____	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) pre-cue the next class session. 1. _____ 2. _____
<a href="http://personal.cege.umn.edu/~smith/">http://personal.cege.umn.edu/~smith/</a>	
97	

# SCALE-UP

Student-Centered Active Learning Environment with Upside-down Pedagogies

**How would you like to teach (or learn) in a classroom like this one at MIT?**

The **purpose** of this website is to share designs for state-of-the-art learning studios, teaching methods, and instructional materials that are based on more than a decade of discipline-based education research.

For a **quick introduction**, visit our [Frequently Asked Questions](#) page, or take a look at this [5 minute video](#) or view a some of these short video clips created by adopters:

[Minnesota](#), [McGill](#), [Iowa](#), [Virginia Tech](#), [Old Dominion](#), [Northern Michigan](#), [Oklahoma](#), [Windward High School](#)

As a **visitor** to the site, you can view classroom designs and find contact information for scores of colleges and a growing number of high schools that are offering highly interactive, collaborative, guided-inquiry-based instruction.

Registered **site members** have access to many more details and classroom materials being developed and tested by faculty from around the world.

**Visitors** may click [here](#) to go to pages describing the work of many of the institutions adopting SCALE-UP.

**Registered site members**, click [here](#) to log in. (There is additional detailed information available only to those who have registered.)



<http://scaleup.ncsu.edu/>

NC STATE UNIVERSITY
Quick Links [Click Here](#)

People

Projects

Publications

Links

Contact Us

Home

SITE DESIGN: / no only appear

Physics Education Research Group



### About the SCALE-UP Project...

This research was supported, in part, by the U.S. Department of Education's Fund for the Improvement of Post-Secondary Education (FIPSE), the National Science Foundation, Hewlett-Packard, Apple Computer, and Course Technology. Opinions expressed are those of the authors and not necessarily those of our sponsors.

The primary goal of the **Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project** is to establish a highly collaborative, hands-on, computer-rich, interactive learning environment for large-enrollment courses.

Educational research indicates that students should collaborate on interesting tasks and be deeply involved with the material they are studying. We promote active learning in a redesigned classroom of 80 students or more. (Of course, smaller classes can also benefit.) We believe the SCALE-UP Project has the potential to radically change the way large classes are taught at colleges and universities. The social interactions between students and with their teachers appears to be the "active ingredient" that make the approach work. As more and more instruction is handled virtually via technology, the relationship-building capability of brick and mortar institutions becomes even more important. The pedagogical methods and classroom management techniques we design and disseminate are general enough to be used in a wide variety of classes at many different types of colleges.

Class time is spent primarily on "solvable" and "ponderable". Essentially these are hands-on activities, resolutions, or interesting questions and problems. There are also some hypothesis-driven labs where students have to write detailed reports. (This [example](#) is more sophisticated than most, but shows what the best students are capable of doing.) Students sit in three groups of three students at a 6 or 7 foot diameter round table. Instructors circulate and work with teams and individuals, engaging them in Socratic-like dialogues. Each table has at least three networked laptops. The setting is very much like a banquet hall, with lively interactions nearly all the time. Many other [colleges and universities](#) are adopting/adapting the SCALE-UP room design and pedagogy. Engineering schools are especially pleased with the [course objectives](#), which fit in well with the requirements for ABET accreditation.

Materials developed for the course were incorporated into what became the leading introductory physics textbook, used by more than 1/3 of all science, math, and engineering students in the country.

<p><b>Impact</b></p> <p>Rigorous evaluations of learning have been conducted in parallel with the curriculum development above. Besides hundreds of hours of classroom video and audio recordings, we also have conducted numerous interviews and focus groups, conducted many conceptual learning assessments (using nationally recognized instruments in a pre/post/transfer process), and collected portfolios of student work. We have data comparing nearly 50,000 traditional and SCALE-UP students. Our findings can be summarized as the following:</p> <ul style="list-style-type: none"> <li>• Ability to solve problems is <a href="#">improved</a></li> <li>• Conceptual understanding is <a href="#">improved</a></li> <li>• Attitudes are <a href="#">improved</a></li> <li>• Failure rates are drastically <a href="#">reduced</a>, especially for women and minorities</li> <li>• "At risk" students do better in later engineering statics classes</li> </ul>	<p><b>Details</b></p> <p>A <a href="#">chapter</a>, describing the approach and its underpinnings is available. A shorter discussion is posted on the PER website, or you can view an <a href="#">audio</a> describing the project from the proceedings of the SigPhi 31 Forum on Reforming Undergraduate Education. The <a href="#">Sleigh News &amp; Observer</a> newspaper also has a <a href="#">feature</a> of the project. The very successful project was <a href="#">discussed</a> in the first issue of the Physics Education Research supplement to Am. J. of Physics. See our <a href="#">publication page</a> for more information.</p> <p>More than 50 colleges and universities across the US have adopted the SCALE-UP approach to their own institutions. In all cases, the basic idea remains the same: get the students working together to write something interesting. That frees the instructor to roam about the room, asking questions and diving up debates. Classes in physics, chemistry, math, engineering, and even literature have been taught this way. If you want more information, please contact <a href="mailto:ou.colson@ncsu.edu">ou.colson@ncsu.edu</a>.</p>
--	--

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

## Cooperative Problem-Based Learning

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



Josh Hibel for The New York Times

The Massachusetts Institute of Technology has changed the way 4 offers some introductory classes. Prof. Gabriele Scibbe of a class on electricity and magnetism.

By SARA RIMER  
Published: January 12, 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 known by its number,

COMMENTS (00)

E-MAIL

PRINT

SINGLE PAGE

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

EDUCATIONAL TRANSFORMATION THROUGH TECHNOLOGY AT MIT - TEAL - MIT OpenCourseWare

EDUCATIONAL TRANSFORMATION THROUGH TECHNOLOGY AT MIT

TEAL Technology-Enhanced Active Learning

In the late 1990s, educators at MIT began to explore the possibilities of using technology to enhance the learning experience. This led to the creation of the Technology-Enhanced Active Learning (TEAL) program. The program's goal was to create a learning environment that was more interactive and collaborative than traditional lecture-based classrooms. This was achieved through the use of technology, such as interactive whiteboards and online resources, to facilitate student learning. The program has since become a model for other institutions looking to transform their classrooms.

LEADERSHIP  
JOHN BELCHER  
PETER DOWNSHIRE  
DAVID LETER

VIDEO - TEAL IN ACTION  
VIDEO - STUDY PHYSICS  
REVIEWING SUCCESS

EDUCATION

In the TEAL program, students learn in a more interactive and collaborative environment. This is achieved through the use of technology, such as interactive whiteboards and online resources, to facilitate student learning. The program has since become a model for other institutions looking to transform their classrooms.

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

The University of Iowa

HOME TEACHING EVENTS PEOPLE ABOUT NEWS RESOURCES

TILE transform interact learn engage

Van Allen TILE Classroom

Highlights

SEP 04 2013 Meet Dr. Bryant McAllister  
Several years ago, the Biology Department initiated a plan to revamp the introductory biology courses taken by undergraduate students in the life sciences.

SEP Trowbridge 134 Gets a New View

Recent News

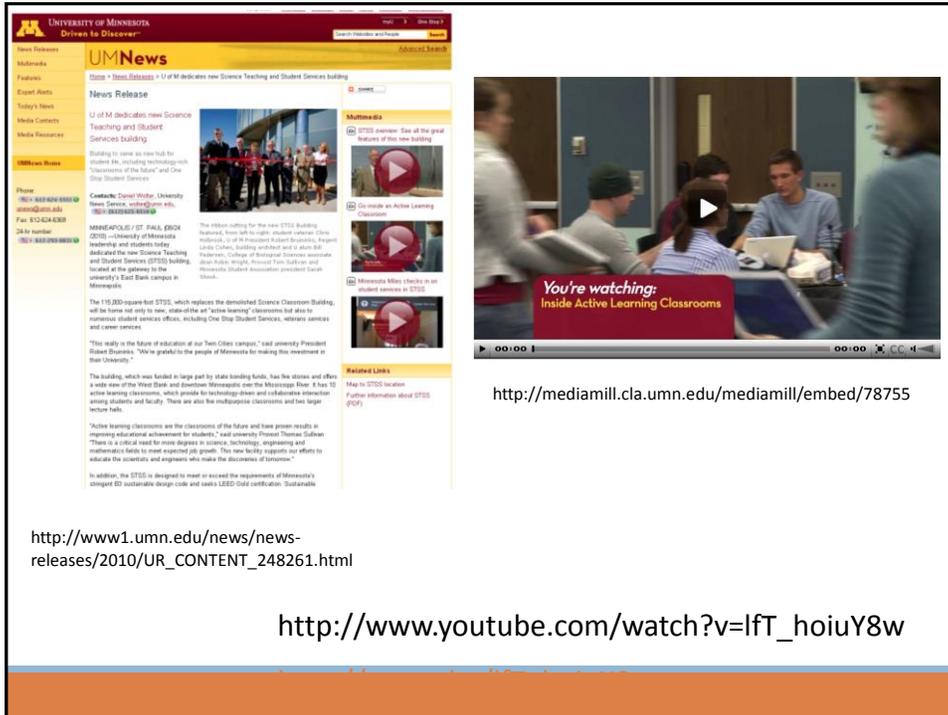
Meet Dr. Bryant McAllister  
Trowbridge 134 Gets a New View  
TILE Tips  
Looking Ahead: Fall 2013  
TILE Events  
A Busy Summer for TILE  
View More Articles

Upcoming Events

10/11/2013 - 1:00pm  
350 Van Allen Hall  
30 North Dubuque St  
Iowa City, IA 52242  
United States  
TILE Labs: Essentials

10/18/2013 - 12:30pm  
1022 Main Library  
125 West Washington St  
Iowa City, IA 52242  
United States  
TILE Labs: Accelerator

http://tile.uiowa.edu/



**UNIVERSITY OF MINNESOTA**  
Driven to Discover

**UMNews**

State + State Capitals + U of M dedicates new Science Teaching and Student Services building

**News Release**

U of M dedicates new Science Teaching and Student Services Building

Building to serve as new hub for active learning technology-rich classrooms of the future and One Stop Student Services

**Campus Corner** White, University Press Center, red@umn.edu, 612.552.5111

**MINNEAPOLIS (ST PAUL, MN) (UPI)** —University of Minnesota leadership and students today dedicated the new Science Teaching and Student Services (STSS) building, located at the gateway to the university's East Bank campus in Minneapolis.

The 115,000-square-foot STSS, which replaces the demolished Science Classroom Building, will be home not only to new, state-of-the-art "active learning" classrooms but also to numerous student services offices, including One Stop Student Services, wireless services and career services.

"This really is the future of education at our Twin Cities campus," said university President Robert Diamond. "We're grateful to the people of Minnesota for making this investment in their University."

The building, which was funded in large part by state bonding funds, has the status and offers a wide view of the West Bank and downtown Minneapolis over the Mississippi River. It has 10 active learning classrooms, which provide for technology-driven and collaborative interaction among students and faculty. There are also the multipurpose classrooms and two lecture halls.

"Active learning classrooms are the classrooms of the future and have proven results in improving educational achievement for students," said university President Thomas Sultman. "There is a critical need for more degrees in science, technology, engineering and mathematics fields to meet regional job growth. We have faculty, equipment and facilities to educate the scientists and engineers who make the difference of tomorrow."

In addition, the STSS is designed to meet or exceed the requirements of Minnesota's stringent B3 sustainable design code and Green LEED-COOL certification. Sustainable

**Related Links**

Map to STSS location  
Further information about STSS (PDF)

**Video Player:** You're watching: Inside Active Learning Classrooms

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

[http://www1.umn.edu/news/news-releases/2010/UR\\_CONTENT\\_248261.html](http://www1.umn.edu/news/news-releases/2010/UR_CONTENT_248261.html)

[http://www.youtube.com/watch?v=lFT\\_hoiuY8w](http://www.youtube.com/watch?v=lFT_hoiuY8w)

# Inside an Active Learning Classroom

STSS at the 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."


UNIVERSITY OF DELAWARE

Powered by Google

UD Home
| [A-Z](#)
| [Find It](#)
| [Maps](#)
| [People](#)
| [My UD](#)

PBL@UD

**Institute for Transforming Undergraduate Education**  
 Problem-Based Learning at University of Delaware

Why PBL?
Our Workshops
Resources
Leaders & Fellows
Partners
In the News

### The Motivation to Learn Begins with a Problem

In a problem-based learning (PBL) model, students engage complex, challenging problems and collaboratively work toward their resolution. PBL is about students connecting disciplinary knowledge to real-world problems—the motivation to solve a problem becomes the motivation to learn.

[PBL@UD](#)

For more than ten years, the Leaders and Fellows of the Institute for Transforming Undergraduate Education (ITUE) have encouraged the adoption of student-centered and active classroom pedagogies—and in particular—the use of PBL in the undergraduate classroom. On- and off-campus workshops are held for faculty and students to enhance their understanding of PBL.

[Recipient of a Hesburgh Certificate of Excellence](#)



The Theodore M. Hesburgh Award was created to acknowledge and reward successful, innovative faculty development programs that enhance undergraduate teaching. ITUE is a recipient of the Hesburgh Certificate of Excellence for its work in implementing problem-based learning in the classroom.



#### What we offer

PBLclearinghouse

**Find great problems for your**

In this peer-reviewed online resource, educators have the opportunity to submit and publish their own problems and articles on problem-based learning.

[Learn more](#)

**PBL Training at a lower cost: Attend our January 4-6 Workshop for an Introduction to PBL!**

This workshop will demonstrate problem-based learning (PBL) and model ways that PBL can be used effectively in all disciplines. We will begin with a problem, and participants will work in teams to experience first hand what this instructional approach entails. We will then move to the main focus of this program: writing effective problem-based materials. Participants will leave the session with new or revised problems for use in their courses.

[Learn more](#)

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

PBL@UD • [info@pbl.udel.edu](mailto:info@pbl.udel.edu)
