Design and Implementation of Cooperative Learning in Introductory Physics

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Survey of Physics Bachelors, 1994-AIP
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...

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

Overall Goals

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

Karl’s Introduction to Cooperative Learning

First Teaching Experience – Third-year course in metallurgical reactions – thermodynamics and kinetics.
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
Research – rotating disk
Practice – leaching of silver bearing metallic copper and printed circuit board waste

\[(\nabla c \bullet v) = D \nabla^2 c\]

\[v_y \frac{dc}{dy} = D \frac{d^2 c}{dy^2}\]
Karl’s Quandry

Practice – Third-year course in metallurgical reactions – thermodynamics and kinetics
Theory – ?
Research – ?
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
Cooperative Learning

Research – Randomized Design Field Experiments
Practice – Formal Teams/Professor’s Role

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

Key Concepts

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

Cooperative Learning Introduced to Engineering – 1981


Undergraduate Teaching Faculty: The 2013–2014 HERI Faculty Survey

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


Cooperative Learning Research Support

- 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

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

- 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).

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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.

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- Thinking Like an Engineer
- Problem Identification
- Problem Formulation
- Problem Representation
- Problem Solving
Team Member Roles

- Task Recorder
- Skeptic/Prober
- Process Recorder

Technical Estimation Problem

**TASK:**

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


Modeling Heuristics


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.


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

<table>
<thead>
<tr>
<th>Plus (+)</th>
<th>Delta (Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Things That Group Did Well</td>
<td>Things Group Could Improve</td>
</tr>
</tbody>
</table>

*Based on First Year Engineering course – Problem-based cooperative learning*

*How to Model It* published in 1990.
**Problem-Based Learning**

1. **Problem posed**
2. **Learn it**
3. **Identify what we need to know**
4. **Apply it**

**Subject-Based Learning**

START

1. **Told what we need to know**
2. **Learn it**
3. **Given problem to illustrate how to use it**

Normative Professional Curriculum:

1. Teach the relevant basic science,
2. Teach the relevant applied science, and
3. Allow for a practicum to connect the science to actual practice.

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**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

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

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

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Teamwork 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 group 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 69 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

Why Emphasize Cooperative Learning and Teamwork?

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

Acquisition of Expertise

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

Key Implications

Distributed

- Repetition over time
  - Spaced vs. massed practice*
  - Spiral curriculum

- Multiple modes of input
  - Visual
  - Audio
  - Kinesthetic
  - Self-explanation
  - Explaining to others

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


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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”
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

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


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.

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)

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
Emargoed 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)

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


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.

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?

<table>
<thead>
<tr>
<th>Skill</th>
<th>Recent Grade*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork skills</td>
<td>40%</td>
</tr>
<tr>
<td>Critical thinking/ reasoning</td>
<td>33%</td>
</tr>
<tr>
<td>Oral/written communication</td>
<td>30%</td>
</tr>
<tr>
<td>Ability to analyze/ organize information</td>
<td>23%</td>
</tr>
<tr>
<td>Innovative thinking creatively</td>
<td>21%</td>
</tr>
<tr>
<td>Able to work with numbers/statistics</td>
<td>3%</td>
</tr>
<tr>
<td>Foreign language proficiency</td>
<td>6%</td>
</tr>
</tbody>
</table>

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

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:

<table>
<thead>
<tr>
<th>Competency</th>
<th>Essential Need Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Thinking/Problem Solving</td>
<td>4.7</td>
</tr>
<tr>
<td>Teamwork</td>
<td>4.6</td>
</tr>
<tr>
<td>Professionalism/Work Ethic</td>
<td>4.5</td>
</tr>
<tr>
<td>Oral/Written Communications</td>
<td>4.4</td>
</tr>
<tr>
<td>Information Technology Application</td>
<td>3.9</td>
</tr>
<tr>
<td>Leadership</td>
<td>3.9</td>
</tr>
<tr>
<td>Career Management</td>
<td>3.6</td>
</tr>
</tbody>
</table>

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


Top Three Main Engineering Work Activities

**Engineering Total**
- Design – 36%
- Computer applications – 31%
- Management – 29%

**Civil/Architectural**
- Management – 45%
- Design – 39%
- Computer applications – 20%

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 Textbook Skills/Obligation: Every textbook has skill and content expectations as well as cooperative and critical group framework skills embedded within.
- Define Cooperative Group (Assign, Authentic Group): Assign students in groups to create mini-teams.
- Align Roles: Assign predetermined interactions by assigning tasks such as Facilitator, Recorder, Facilitator (Coach) and Collaborator (Coordinate).
- Arrange Roles: Group assignments should be “task driven,” not to say that assigned tasks are the best for students. They should be fun.
- Plan Group: Assignments should give a “pull out” or “pull together” experience. Give only one paper to the group or give each member a part of the paper to be shared.

Explain Task and Cooperative Structure
- Explain the Academic Task: Explain the task, its objectives, expectations, and principles of student activity (think, pair, share).
- Explain the Context for Success: Student work should be embedded in a whole environment. Make clear your values for evaluating student work.

Structure Individual Cooperative: Emphasize the “pull out” or “pull together.”
- Think and Pair Cooperative: Emphasize the “pull out” or “pull together.”
- Think and Pair Cooperative: Emphasize the “pull out” or “pull together.”
- Think and Pair Cooperative: Emphasize the “pull out” or “pull together.”
- Think and Pair Cooperative: Emphasize the “pull out” or “pull together.”

Evaluate and Process:
- Evaluate Individual Learning: assess and evaluate the quality and quantity of student learning. Identify strengths in the assessment process.
- Evaluate Group Learning: Emphasize the contribution of the group to student learning. Identify strengths and weaknesses in the assessment process.
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]
**Book Ends on a Class Session**

- 10-12 Minute Lecture
- 3-4 min. Turn to Partner
- 10-12 Minute Lecture
- 3-4 min. Turn to Partner
- 10-12 Minute Lecture
- 5-6 Minute Summary


**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
Informal Cooperative Learning Planning Form

**Description of the Lecture**

1. Lecture Topic:  
2. Objective: 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 format - 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 on 15 minutes to ensure that participants understand and process the information being presented. Instruct students to use the formulae, 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 Questions (s)**

Give an ending discussion task and require students to come to consensus, write down the pair or team's answer, sign the paper, and hand it in. Summaries inform the students agree with the answer, can explain it, and guarantee that their partners can explain it. The questions might ask for a summary, elaboration, or extension of the material presented or to prove the next day's assignment:
1.  
2.  

http://personal.cege.umn.edu/~smith/

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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 the 5 minute video or view some of these short video clips created by students.

Minnesota, McGill, Iowa, Virginia Tech, Old Dominion, Northern Michigan, Oklahoma, Woodward High School

As a visitor to this 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 more details and classroom materials being developed and tested by faculty from around the world.

Visitors may click [here](http://scaleup.ncsu.edu/) to go to pages describing the work of many of the institutions adopting SCALE-UP. Registered site members, click [here](http://scaleup.ncsu.edu/) to log in. (There is additional detailed information available only to those who have registered.)
Cooperative Problem-Based Learning

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

The Massachusetts Institute of Technology has changed the way it teaches introductory physics: Peer-Assisted Learning at a Lecture Hall Instead of Blackboards

By CARLA TOMS
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 nickname, "the blackboard."
TEAL
Technology-Enhanced Active Learning

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

http://tile.uiowa.edu/
Inside an Active Learning Classroom

STSS at the University of Minnesota

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

Recipients of a Hesburgh Certificate of Excellence

The Theodore M. Hesburgh Award was created to acknowledge and reward successful, innovative faculty professional 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.

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