Design and Implementation of Cooperative Learning

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Workshop for the Associated Colleges of the St. Lawrence Valley

November 6, 2010
Workshop Layout

- Welcome & Overview
- Integrated Course Design (CAP Model)
  - Content
  - Assessment
  - Pedagogy
- Cooperative Learning
  - Informal – Bookends on a Class Session
  - Formal Cooperative Learning
    - Problem-Based Cooperative Learning
- Develop an Application
- Wrap-up and Next Steps
Workshop Objectives

• Participants will learn about the instructor’s role in designing, structuring, and implementing cooperative learning. Specific learning outcomes include:
  – Describe key features of the Content (outcomes) – Assessment – Pedagogy Integrated Design Approach
  – Develop/refine rationale for Cooperative Learning
  – Describe key features of cooperative learning
  – Apply cooperative learning to classroom practice
  – Make connections between cooperative learning and desired outcomes of courses and programs
Background Knowledge Survey

• Familiarity with
  – Cooperative Learning Strategies
    – Informal – turn-to-your-neighbor
    – Formal – cooperative problem-based learning
  – Approaches to Course Design
    • Wiggins & McTighe – Understanding by Design (Backward Design)
    • Fink – Creating Significant Learning Experiences
    • Felder & Brent – Effective Course Design
  – Research
    • Student engagement – NSSE
    • Cooperative learning
    • How People Learn

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

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


• Curriculum-Instruction-Assessment Triad (Pellegrino, 2006)
Some Important Principles About Learning and Understanding

The first important principle about how people learn is that students come to the classroom with preconceptions about how the world works which include beliefs and prior knowledge acquired through various experiences.

The second important principle about how people learn is that to develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.

A third critical idea about how people learn is that a “metacognitive” approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

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
Reflection and Dialogue

- Individually reflect on your familiarity with (1) Integrated Course Design and (2) Cooperative Learning. Write for about 1 minute
  - Key ideas, insights, applications – Success Stories
  - Questions, concerns, challenges
- Discuss with your neighbor for about 3 minutes
  - Select one Insight, Success Story, Comment, Question, etc. that you would like to present to the whole group if you are randomly selected
- Whole group discussion
Key Resources

• Wiggins & McTighe – Understanding by Design

• Pellegrino – Rethinking and Redesigning Curriculum, Instruction and Assessment

http://books.google.com/books?id=N2EfKlyUN4QC&printsec=frontcover&source=gbs_v2_summary_r&cad=0#v=onepage&q=&f=false

http://www.skillscommission.org/commissioned.htm
Backward Design Approach
Wiggins & McTighe

Stage 1. Identify Desired Results
• Enduring understanding
• Important to know and do
• Worth being familiar with

Stage 2. Determine Acceptable Evidence

Stage 3. Plan Learning Experiences and Instruction

Establishing Curricular Priorities

Worth being familiar with

Important to know and do

Enduring understanding
Related Integrated Course Design Model

  http://www.deefinkandassociates.com/GuidetoCourseDesignAug05.pdf
The Key Components Of INTEGRATED COURSE DESIGN

Model 1

Learning Goals

Teaching and Learning Activities

Feedback & Assessment

Situational Factors

A Self-Directed Guide to Designing Courses for Significant Learning
Backward Design

Stage 1. Identify Desired Results

Filter 1. To what extent does the idea, topic, or process represent a big idea or having enduring value beyond the classroom?

Filter 2. To what extent does the idea, topic, or process reside at the heart of the discipline?

Filter 3. To what extent does the idea, topic, or process require uncoverage?

Filter 4. To what extent does the idea, topic, or process offer potential for engaging students?
<table>
<thead>
<tr>
<th>Learning Goals for Course/Session/Learning Module:</th>
<th>Ways of Assessing</th>
<th>Actual Teaching-Learning</th>
<th>Helpful Resources:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<td>(e.g., people, things)</td>
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<td>2.</td>
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Backward Design

Stage 2. Determine Acceptable Evidence

Types of Assessment

Quiz and Test Items:
Simple, content-focused test items

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

Performance Tasks or Projects:
Complex challenges that mirror the issues or problems faced by graduates, they are authentic
Taxonomies of Types of Learning

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

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

Facets of understanding (Wiggins & McTighe, 1998)

Taxonomy of significant learning (Fink, 2003)

Evaluating the quality of learning: The SOLO taxonomy (Biggs & Collis, 1982)
The Six Major Levels of Bloom's Taxonomy of the Cognitive Domain
(with representative behaviors and sample objectives)

**Knowledge.** Remembering information *Define, identify, label, state, list, match*
- Identify the standard peripheral components of a computer
- Write the equation for the Ideal Gas Law

**Comprehension.** Explaining the meaning of information *Describe, generalize, paraphrase, summarize, estimate*
- In one sentence explain the main idea of a written passage
- Describe in prose what is shown in graph form

**Application.** Using abstractions in concrete situations *Determine, chart, implement, prepare, solve, use, develop*
- Using principles of operant conditioning, train a rate to press a bar
- Derive a kinetic model from experimental data

**Analysis.** Breaking down a whole into component parts *Points out, differentiate, distinguish, discriminate, compare*
- Identify supporting evidence to support the interpretation of a literary passage
- Analyze an oscillator circuit and determine the frequency of oscillation

**Synthesis.** Putting parts together to form a new and integrated whole *Create, design, plan, organize, generate, write*
- Write a logically organized essay in favor of euthanasia
- Develop an individualized nutrition program for a diabetic patient

**Evaluation.** Making judgments about the merits of ideas, materials, or phenomena
*Appraise, critique, judge, weigh, evaluate, select*
- Assess the appropriateness of an author's conclusions based on the evidence given
- Select the best proposal for a proposed water treatment plant
### The Cognitive Process Dimension

<table>
<thead>
<tr>
<th>Cognitive Process Dimension</th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
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<td>b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge</td>
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(Anderson & Krathwohl, 2001).
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<td>Retrieving relevant knowledge from long-term memory</td>
<td>Determining the meaning of instructional messages, including oral, written, and graphic communication.</td>
<td>Carrying out or using a procedure in a given situation</td>
<td>Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose</td>
<td>Making judgments based on criteria and standards</td>
<td>Putting elements together to form a novel, coherent whole or make an original product</td>
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<td>Compare</td>
<td>Defend</td>
<td>Combine</td>
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<td>Identify</td>
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<td>Knowledge Dimension</td>
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When we truly understand, we
Can explain - cognitive
Can interpret - cognitive
Can apply - cognitive
Have perspective - affective
Can empathize - affective
Have self-knowledge - metacognitive
A TAXONOMY OF SIGNIFICANT LEARNING EXPERIENCES

1. Foundational Knowledge
   • "Understand and remember" learning
     For example: facts, terms, formulae, concepts, principles, etc.

2. Application
   • Thinking: critical, creative, practical (problem-solving, decision-making)
   • Other skills
     For example: communication, technology, foreign language
   • Managing complex projects

3. Integration
   • Making "connections" (i.e., finding similarities or interactions) . . .
     Among: ideas, subjects, people

4. Human Dimensions
   • Learning about and changing one's SELF
   • Understanding and interacting with OTHERS

5. Caring
   • Identifying/Changing one's feelings, interests, values

6. Learning How to Learn
   • Becoming a better student
   • Learning how to ask and answer questions
   • Becoming a self-directed learner
SOLO Taxonomy

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

- **Pre-structural** - The task is not attacked appropriately; the student hasn’t really understood the point and uses too simple a way of going about it.
- **Uni-structural** - The student's response only focuses on one relevant aspect.
- **Multi-structural** - The student's response focuses on several relevant aspects but they are treated independently and additively. Assessment of this level is primarily quantitative.
- **Relational** - The different aspects have become integrated into a coherent whole. This level is what is normally meant by an adequate understanding of some topic.
- **Extended abstract** - The previous integrated whole may be conceptualised at a higher level of abstraction and generalised to a new topic or area.

Backward Design

Stage 3. Plan Learning Experiences & Instruction

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

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

See Cooperative Learning Handout (CL College-804.doc)
Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence (all members must cooperate to complete the task) and individual and group accountability (each member is accountable for the complete final outcome).

Key Concepts

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

## Positive Interdependence

<table>
<thead>
<tr>
<th>Goal Interdependence (essential)</th>
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<tbody>
<tr>
<td>1. All members show mastery</td>
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<tr>
<td>2. All members improve</td>
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<tr>
<td>3. Add group member scores to get an overall group score</td>
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<tr>
<td>4. One product from group that all helped with and can explain</td>
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</tbody>
</table>

<table>
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<tr>
<th>Role (Duty) Interdependence</th>
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<tbody>
<tr>
<td>Assign each member a role and rotate them</td>
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<table>
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<tr>
<th>Resource Interdependence</th>
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<tbody>
<tr>
<td>1. Limit resources (one set of materials)</td>
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<tr>
<td>2. Jigsaw materials</td>
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<tr>
<td>3. Separate contributions</td>
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<thead>
<tr>
<th>Task Interdependence</th>
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<tbody>
<tr>
<td>1. Factory-line</td>
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<td>2. Chain Reaction</td>
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<tr>
<th>Outside Challenge Interdependence</th>
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<tbody>
<tr>
<td>1. Intergroup competition</td>
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<tr>
<td>2. Other class competition</td>
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<table>
<thead>
<tr>
<th>Identity Interdependence</th>
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<tbody>
<tr>
<td>Mutual identity (name, motto, etc.)</td>
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<thead>
<tr>
<th>Environmental Interdependence</th>
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<tr>
<td>1. Designated classroom space</td>
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<tr>
<td>2. Group has special meeting place</td>
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<tr>
<th>Fantasy Interdependence</th>
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<td>Hypothetical interdependence in situation (&quot;You are a scientific/literary prize team, lost on the moon, etc.&quot;)</td>
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<th>Reward/Celebration Interdependence</th>
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<tr>
<td>1. Celebrate joint success</td>
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<td>2. Bonus points (use with care)</td>
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<td>3. Single group grade (when fair to all)</td>
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## Individual Accountability

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<thead>
<tr>
<th>Ways to ensure no slackers:</th>
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<tr>
<td>1. Keep group size small (2-4)</td>
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<td>2. Assign roles</td>
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<td>3. Randomly ask one member of the group to explain the learning</td>
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<td>4. Have students do work before group meets</td>
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<td>5. Have students use their group learning to do an individual task afterward</td>
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<td>6. Everyone signs: &quot;I participated, I agree, and I can explain&quot;</td>
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<tr>
<td>7. Observe &amp; record individual contributions</td>
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<table>
<thead>
<tr>
<th>Ways to ensure that all members learn:</th>
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<tbody>
<tr>
<td>1. Practice tests</td>
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<tr>
<td>2. Edit each other’s work and sign agreement</td>
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<tr>
<td>3. Randomly check one paper from each group</td>
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<tr>
<td>4. Give individual tests</td>
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<td>5. Assign the role of checker who has each group member explain out loud</td>
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<td>6. Simultaneous explaining: each student explains their learning to a new partner</td>
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## Face-to-Face Interaction

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<tr>
<th>Structure:</th>
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<tbody>
<tr>
<td>1. Time for groups to meet</td>
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<td>2. Group members close together</td>
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<td>3. Small group size of two or three</td>
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<td>4. Frequent oral rehearsal</td>
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<tr>
<td>5. Strong positive interdependence</td>
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<tr>
<td>6. Commitment to each other’s learning</td>
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<tr>
<td>7. Positive social skill use</td>
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<tr>
<td>8. Celebrations for encouragement, effort, help, and success!</td>
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</tbody>
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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

Advanced Organizing

Vol. 1
Vol. 2
Vol. 3
Book Ends on a Class Session

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

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

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

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

Formulate-Share-Listen-Create

Informal Cooperative Learning Group
Introductory Pair Discussion of a

FOCUS QUESTION

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

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

Session Summary
(Minute Paper)

Reflect on the session:

1. Most interesting, valuable, useful thing you learned.
2. Things that helped you learn.
3. Question, comments, suggestions.
4. Pace: Too slow 1 . . . . 5 Too fast
5. Relevance: Little 1 . . . 5 Lots
6. Instructional Format: Ugh 1 . . . 5 Ah
Q4 – Pace: Too slow 1 . . . 5 Too fast (3.0)
Q5 – Relevance: Little 1 . . . 5 Lots (3.9)
Q6 – Format: Ugh 1 . . . 5 Ah (4.1)
Q4 – Pace: Too slow 1 . . . 5 Too fast (3.3)
Q5 – Relevance: Little 1 . . . 5 Lots (4.2)
Q6 – Format: Ugh 1 . . . 5 Ah (4.4)
Informal CL (Book Ends on a Class Session) with Concept Tests

Physics
Peer Instruction
Peer Instruction – www.prenhall.com
Richard Hake – http://www.physics.indiana.edu/~hake/

Chemistry
Chemistry ConcepTests - UW Madison
www.chem.wisc.edu/~concept

Video: Making Lectures Interactive with ConcepTests
ModularChem Consortium – http://mc2.cchem.berkeley.edu/

STEMTEC

Harvard – Derek Bok Center
The “Hake” Plot of FCI

![Graph showing the "Hake" Plot of FCI with various data points and lines representing different groups: UMn Cooperative Groups, UMn Traditional, ASU(nc), WP*, ASU(c), SDI, UMn-CL+PS, WP, PI(HU), and HU.](image-url)
Richard Hake (Interactive engagement vs traditional methods)
http://www.physics.indiana.edu/~hake/

Fig. 2. Histogram of the average normalized gain \( \langle g \rangle \): dark (red) bars show the fraction of 14 traditional courses (N = 2084), and light (green) bars show the fraction of 48 interactive engagement courses (N = 4458), both within bins of width \( \delta \langle g \rangle = 0.04 \) centered on the \( \langle g \rangle \) values shown.
Fig. 1. %<Gain> vs %<Pretest> score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total N = 6542 students: 14 traditional (T) courses (N = 2084) which made little or no use of interactive engagement (IE) methods, and 48 IE courses (N = 4458) which made considerable use of IE methods. Slope lines for the average of the 14 T courses <<g>>14T and 48 IE courses <<g>>48IE are shown, as explained in the text.
Physics (Mechanics) Concepts: The Force Concept Inventory (FCI)

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

Can be used at any time
Can be short term and ad hoc
May be used to break up a long lecture
Provides an opportunity for students to process material they have been listening to (Cognitive Rehearsal)
Are especially effective in large lectures
Include "book ends" procedure
Are not as effective as Formal Cooperative Learning or Cooperative Base Groups
Strategies for Energizing Large Classes: From Small Groups to Learning Communities:

Jean MacGregor, James Cooper, Karl Smith, Pamela Robinson

New Directions for Teaching and Learning, No. 81, 2000.

Jossey-Bass
Active Learning: Cooperation in the College Classroom

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

See Cooperative Learning Handout (CL College-804.doc)
Formal Cooperative Learning
Task Groups
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 Grads*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork skills</td>
<td>44%</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 assemble/ organize information</td>
<td>21%</td>
</tr>
<tr>
<td>Innovative/thinking creatively</td>
<td>20%</td>
</tr>
<tr>
<td>Able to work with numbers/statistics</td>
<td>9%</td>
</tr>
<tr>
<td>Foreign language proficiency</td>
<td>3%</td>
</tr>
</tbody>
</table>

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

Top Three Main Engineering Work Activities

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

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

Teamwork Skills

• Communication
• Listening and Persuading
• Decision Making
• Conflict Management
• Leadership
• Trust and Loyalty
Ideo's five-point model for strategizing by design:

Hit the Streets
Recruit T-Shaped People
Build to Think
The Prototype Tells a Story
Design Is Never Done

Tom Friedman
Horizontalize Ourselves

CQ+PQ>IQ

AAC&U College Learning
For the New Global Century
Professor's Role in Formal Cooperative Learning

1. Specifying Objectives

2. Making Decisions

3. Explaining Task, Positive Interdependence, and Individual Accountability

4. Monitoring and Intervening to Teach Skills

5. Evaluating Students' Achievement and Group Effectiveness
Formal Cooperative Learning – Types of Tasks

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

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

John Bransford, Nancy Vye and Helen Bateman. Creating High-Quality Learning Environments: Guidelines from Research on How People Learn
Challenge-Based Instruction with the Legacy Cycle

The Challenges

Go Public

Test Your Mettle

Research & Revise

Generate Ideas

Multiple Perspectives

Legacy Cycle

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

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

START
Problem-Based Cooperative Learning

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

Estimation Exercise
Problem Based Cooperative Learning Format

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

INDIVIDUAL: Estimate answer. Note strategy.

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

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

EVALUATION: Best answer within available resources or constraints.

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

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

INTERGROUP COOPERATION: Whenever it is helpful, check procedures, answers, and strategies with another group.
PROBLEM-BASED LEARNING

UD PBL articles and books

UD PBL in the news

Sample PBL problems

UD PBL courses and syllabi

PBL Clearinghouse

PBL Conferences and Other PBL sites

Institute for Transforming Undergraduate Education

Other related UD sites

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

PBL2002:
A Pathway to Better Learning

Recipient of 1999 Hesburgh Certificate of Excellence

Please direct comments, suggestions, or requests to ud-pbl@udel.edu.

"http://www.udel.edu/pbl/"
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http://www.udel.edu/pbl/
Cooperative Base Groups

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

• Design Framework – How People Learn (HPL) & Backward Design Process
  – Creating High Quality Learning Environments (Bransford, Vye & Bateman) --
    http://www.nap.edu/openbook/0309062927/html/

• Content Resources

• Cooperative Learning - Instructional Format explanation and exercise to model format and to engage workshop participants
  – Cooperative Learning (Johnson, Johnson & Smith)
    • Smith web site – www.ce.umn.edu/~smith

• Other Resources
  – University of Delaware PBL web site – www.udel.edu/pbl