Content, Assessment and Pedagogy (CAP): An Integrated Design Approach

Instructional Team:
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2009 Workshop for The Committee for the Formation of Engineers Puebla-Tlaxcala

Session 3 – July 2, 2009
Session 3 Overview

- Welcome & Overview
- Reflections and Session 3
  - Participant “Think-Pair-Share” – Highlights, Insights, and Questions from Session 2
- Pedagogy
  - Planning Active and Cooperative Learning
- Aligning Content, Assessment, and Pedagogy
- Assignments & Next Steps
Resource: Learning that Lasts

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Resource: Classroom Assessment Techniques

- What classroom assessment entails and how it works.
- How to plan, implement, and analyze assessment projects.
- Twelve case studies that detail the real-life classroom experiences of teachers carrying out successful classroom assessment projects.
- Fifty classroom assessment techniques
- Step-by-step procedures for administering the techniques
- Practical advice on how to analyze your data

http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/assess-2.htm
http://www.celt.iastate.edu/teaching/cat.html
Exercise 1

- Three volunteers that would like to share one objective and get feedback from the instructional team
Exercise 2

- Find a new partner (someone that is not so familiar with your course).
- Share one learning objective and its assessment method(s)
- Provide feedback to your partner
Think-Pair-Share about Session 2

1. Reflect on session 2. Briefly describe your major learning, insights, and questions.

2. Explain what you think is meant by:
   a. Pedagogies of Engagement – Active and Cooperative Learning
   b. Alignment of Content, Assessment and Pedagogy

3. Talk with other members of your group.
Pedago-pathologies

- Amnesia
- Fantasia
- Inertia

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

What do we do about these pathologies? - Lee Shulman

- Activity
- Reflection
- Collaboration
- Passion

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

The Massachusetts Institute of Technology has changed the way it offers some introductory classes. Prof. Gabriella Scollo at 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, 4-131.

The change is not yet complete, but it is has been underway for a number of years, as the institute tries to modernize its teaching methods. The new approach, which is called ‘engaged pedagogy,’ involves more interaction between students and their teachers.

The change is also being driven by outside forces, including calls for evidence-based teaching practices.

January 13, 2009—New York Times

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

Calls for evidence-based teaching practices
http://web.mit.edu/edtech/casestudies/teal.html#video
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 100 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 makes 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 colages.

Classroom activity is centered around "tangibles" and "non-tangibles." Essentially these are hands-on activities, simulations, or interesting questions and problems. There are also some hypothesis-driven labs where students have to write detailed reports. (This aspect is more sophisticated than most, but shows what the best students are capable of doing.) Students sit in three groups of three students at 6' or 7' foot diameter round tables. 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.
Cooperative Learning

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing
Cooperative Learning (cont.)

Figure A.1 A General Theoretical Framework

- Social Interdependence Perspective
- Cognitive-Developmental Perspective
- Behavioral-Social Perspective

- Goal Interdependence
- Resource And Role Interdependence
- Reward And Task Interdependence

- Promotive Interaction

- Increased Motivation

- Enhanced Individual Learning And Productivity
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
Faculty interest in higher levels of inquiry in engineering education

- **Level 0**  Teacher
  - Teach as taught

- **Level 1**  Effective Teacher
  - Teach using accepted teaching theories and practices

- **Level 2**  Scholarly Teacher
  - Assesses performance and makes improvements

- **Level 3**  Scholar of Teaching and Learning
  - Engages in educational experimentation, shares results

- **Level 4**  Engineering Education Researcher
  - Conducts educational research, publishes archival papers

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

- People working in teams to accomplish a common goal

  - **Positive interdependence** (all members must cooperate to complete the task)

  - **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
Individual & Group Accountability
# Cooperative Learning

## Positive Interdependence

**Goal Interdependence** (essential)
1. All members show mastery
2. All members improve
3. Add group member scores to get an overall group score
4. One product from group that all helped with and can explain

**Role (Duty) Interdependence**
Assign each member a role and rotate them

**Resource Interdependence**
1. Limit resources (one set of materials)
2. Jigsaw materials
3. Separate contributions

**Task Interdependence**
1. Factory-line
2. Chain Reaction

**Outside Challenge Interdependence**
1. Intergroup competition
2. Other class competition

**Identity Interdependence**
Mutual identity (name, motto, etc.)

**Environmental Interdependence**
1. Designated classroom space
2. Group has special meeting place

**Fantasy Interdependence**
Hypothetical interdependence in situation ("You are a scientific/literary prize team, lost on the moon, etc.")

**Reward/Celebration Interdependence**
1. Celebrate joint success
2. Bonus points (use with care)
3. Single group grade (when fair to all)

## Individual Accountability

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

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

## Face-to-Face Interaction

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

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Book Ends on a Class Session

Diagram:
- Advanced Organizing
- Vol. 1: 10-12 Minute Lecture
- Vol. 2: 3-4 min. Turn to Partner
- Vol. 3: 10-12 Minute Lecture
- 5-6 Minute Summary
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.
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

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 (3.3)
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/
Informal CL (Book Ends on a Class Session) with Concept Tests

**STEMTEC**

**Harvard**
Thinking Together & From Questions to Concepts Interactive Teaching in Physics:
Derek Bok Center – www.fas.harvard.edu/~bok_cen/
Fig. 2. Histogram of the average normalized gain $g$: 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 $\delta g = 0.04$ centered on the $g$ values shown.
Fig. 1. \%
\text{Gain} vs \%
\text{Pretest} score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total \(N = 6842\) students: 14 traditional (T) courses \(N = 2084\) which made little or no use of interactive engagement (IE) methods, and 48 IE courses \(N = 4458\) which made considerable use of IE methods. Slope lines for the average of the 14 T courses \(\langle g \rangle_{14T}\) and 48 IE courses \(\langle g \rangle_{48IE}\) are shown, as explained in the text.
The “Hake” Plot of FCI

The graph shows a scatter plot with the x-axis representing Pretest (Percent) ranging from 20.00 to 80.00 and the y-axis representing Gain (Percent) ranging from 0.00 to 35.00. The data points are categorized into three groups:

- **UMn Cooperative Groups**: Represented by a red cross (X) and labeled as UMn-CL+PS.
- **UMn Traditional**: Represented by a black square and labeled as HU.
- **ASU(nc)**: Represented by a black triangle and labeled as ASU(nc).
- **ALS**: Represented by a black circle and labeled as ALS.
- **SDI**: Represented by a black diamond and labeled as SDI.
- **WP**: Represented by a black square and labeled as WP.
- **WP***: Represented by a black square and labeled as WP*.

The graph includes lines for different groups, indicating trends in the data.
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
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>
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<th>Skill</th>
<th>Recent Grads*</th>
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<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>
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* 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
Teamwork Skills

- Design team failure is usually due to failed team dynamics
  
  (Leifer, Koseff & Lenshow, 1995).

- It’s the soft stuff that’s hard, the hard stuff is easy
  
  (Doug Wilde, quoted in Leifer, 1997)

- Professional Skills
  
Teamwork

PERFORMANCE LEVEL

TYPE OF GROUP

Individual Members

Pseudo-group

Traditional Group

Cooperative Group

High-performing Cooperative Group
Characteristics of Effective Teams
Characteristics of Effective Teams

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

Hackman – Leading Teams

- Real Team
- Compelling Direction
- Enabling Structure
- Supportive Organizational Context
- Available Expert Coaching

Team Diagnostic Survey (TDS)
https://research.wjh.harvard.edu/TDS/
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
Challenged-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

1. Generate Ideas
2. Multiple Perspectives
3. Test Your Mettle
4. Research & Revise
5. Go Public
6. Generate Ideas

Legacy Cycle

https://repo.vanth.org/portal/public-content/star-legacy-cycle/star-legacy-cycle
Kolb’s Experiential Learning Cycle

1. Concrete Experience
2. Observation and Reflections
3. Formulation of abstract concepts and generalizations
4. Testing implications of concepts in new situations
5 E Learning Cycle Model

- Engage
- Explore
- Explain
- Elaborate
- Evaluate

http://faculty.mwsu.edu/west/maryann.coe/coe/inquire/inquiry.htm
Problem-Based Learning

START

Problem Posed

Apply it

Identify what we need to know

Learn it
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
Problem Based Cooperative Learning Format

- **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 Duck

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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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
Exercise

- What kind of learning environments will produce the outcomes you are assessing?

- Complete your worksheet using the questions on the next page.
Backward Design

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?
# Worksheet for Designing a Course/Class Session/Learning Module

<table>
<thead>
<tr>
<th>Learning Goals for Course/Session/Learning Module:</th>
<th>Ways of Assessing This Kind of Learning:</th>
<th>Actual Teaching-Learning Activities:</th>
<th>Helpful Resources: (e.g., people, things)</th>
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Next Steps

- What questions do you still have about the next steps?

- What information do you need to explain your plan into a year-long project?