

# Engaging Students through Active, Cooperative, and Problem-Based Learning



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29 June 2016

Mercantec Workshop 1

# Instructional Objectives

(What should the students be able to do at the end of the course?)



AL  
CL  
PBL  
IBL  
SL  
Field Trips  
Case Studies  
Role Playing

# Learning Activities

(How do my students learn best? What do I do best?)

Lectures  
Labs  
Simulation  
IT  
Debate

# Assessment

(What is acceptable evidence of learning?)

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# Session Objectives

- ❑ Experience AL, PBL, CL.
- ❑ Identify the elements necessary to make CL work.
- ❑ Discuss how to implement these elements into CL activities.
- ❑ Discuss the challenges in implementing CL.
- ❑ Assess the effectiveness of student teams.

**Form teams of 4!**  
**Get to know your teammates!**

# Team Leader

## Responsibilities:

- Keep the process enjoyable and rewarding for all team members.
- Make sure each and every member participates and performs within their role.
- Guide the discussion and keep members on task.
- Manage time, stress, and conflict.
- Ensure that **all members can articulate** what has been learned.
- Contribute to the team and actively learn.
- Maintain accountability for the overall performance of the team.

# Recorder

## Responsibilities:

- Record instructions and each member's role at the beginning of a task.
- Document legibly and accurately team ideas, discoveries, answers and questions into a “Recorder's Journal”.
- Integrate and synthesize when several ideas are presented.
- Control information flow, articulate concepts in alternative forms, if necessary.
- Contribute to the team and actively learn.

# Spokesperson

## Responsibilities:

- Speak for the team when called to do so.
- Ask questions posed by the team, or request clarification.
- Use the recorder's report to share the team's discoveries and insights.
- Collaborate with the recorder.
- Contribute to the group and actively learn.

# Reflector

## Responsibilities:

- Observe performance, interactions + dynamics among team members.
- Be a good listener + observer.
- Analyze + record **team strengths, improvements needed, + insights** into a “**Reflector’s Journal**”.  
Write evaluations positively + constructively.
- Intervene with observations about the process + suggest strategies for change.
- Contribute to the group and actively learn.

# Assign roles within your team:

- ❑ **Captain:** person in team most familiar with fluid mechanics or the one who goes swimming more often.
- ❑ **Recorder:** person in team to the right of the captain.
- ❑ **Spokesperson:** person in team to the left of the captain.
- ❑ **Reflector:** the 4<sup>th</sup> person.

# HERO'S FOUNTAIN

## Individual Effort ( 2 min )

- Think about the problem **quietly** while sharing the equipment. Don't talk to each other.
- Write down your explanation for the formation of the fountain.
- Don't take the bottles apart!
- Try to guess what is going on inside the bottleneck.
- Estimate the speed of the H<sub>2</sub>O through the lower tube.

# HERO'S FOUNTAIN

## Team Effort ( 3 min )

- Discuss individual explanations / answers within each group. Revise as necessary. Come up with team explanation / answers.
- Feel free to take the bottles apart and examine them carefully!
- Estimate the speed of the H<sub>2</sub>O going up the fountain.
- Why is the flow of the H<sub>2</sub>O up the fountain discontinuous?
- You are done **only when every member of your team** knows the answers and understands the explanations!

# HERO'S FOUNTAIN

## Challenge Question 1 : Team Effort

How can we demonstrate that a partial vacuum is formed in the upper bottle? (i.e., that the pressure inside the upper bottle is indeed lower than atmospheric?)

# HERO'S FOUNTAIN

## Challenge Question 2 : Team Effort

How can we demonstrate that the air is compressed in the lower bottle? (i.e., that the pressure inside the lower bottle is indeed higher than ambient atmospheric pressure?)

# Reflection

## Individually ( 2 min )

Write in your journals:

- The **most interesting** thing you learned from this problem.
- An **outstanding question** you still have.

# Active Learning

**All learning is active!** The learner must always do something in order to learn (ex. read, think, write, solve problems, etc.).

- ❑ **Old paradigm:** the learner performs these activities after he / she leaves the classroom.
- ❑ **New paradigm:** AL implies that these activities are also performed in the classroom under the guidance of the teacher!

## Sophocles

*“One must learn  
by doing the thing,  
for though you think you know it,  
you have no certainty,  
until you try.”*

**Wilbert J. McKeachie**

**“Teaching Tips:**

**Strategies, Research, and Theory for College & University Teachers”**

**10<sup>th</sup> ed., Houghton Mifflin, 1999, ch. 14.**

The bottleneck in educational efficiency is that **learning to think** requires **thinking** and **communicating** the thinking through **talking, writing, or doing**, so that others can react to it.

# PROBLEM-BASED LEARNING

- Students are **first** presented with a problem / case study.
- **Then** they work in teams to:
  - ❖ Organize their ideas and previous knowledge related to the problem
  - ❖ Pose questions on aspects of the problem they do not understand.

# PROBLEM-BASED LEARNING ( cont' d )

- ❑ Lecturing follows but is kept to a minimum.
- ❑ Students are coached to search for information; work cooperatively to find answers.
- ❑ Faculty act as coaches and facilitators, prompting with questions and providing guidance as necessary.

# Why use PBL ?

- ❑ **Topic-driven** instruction is logical for someone who **already understands** the subject. It is not necessarily logical for someone who is **trying to learn** the subject.
- ❑ PBL keeps students **engaged** by using a problem as a point of focus.

# Why use PBL ? ( cont' d )

- ❑ Students take more **responsibility for their learning** (lifelong learning)
- ❑ Students become **more receptive** to theory discussed in class because they now have a purpose for all this (i.e., the problem at hand)
- ❑ Students **learn how to formulate**, define, and analyze problems (not the case when students follow solutions from example problems!)

# Why use PBL ? ( cont' d )

- ❑ Students acquire **problem-solving skills** and **confidence** in their technical competence, especially in situations where the problem is ill-defined and there is no single answer.
- ❑ Students develop **communication** and **team skills**.

# COOPERATIVE LEARNING

Instruction which involves people working in teams to accomplish a common goal, under conditions that involve

1. Positive interdependence
2. Face-to-face promotive interaction
3. Individual accountability
4. Group accountability
5. Group processing.

Johnson, D.W., Johnson, R.T., Smith, K. A.

# Positive Interdependence

- ❑ All members must cooperate to complete the task.
- ❑ Team members swim together or sink together.
- ❑ Each team member must:
  - (a) do own part and
  - (b) teach own part to other members.

# Positive Interdependence

To enforce:

- One set of answers from the group; everyone has to agree.
- Positive reward interdependence.
- Negative reward interdependence.
- Jigsaw puzzle.
- Quiz students about each other's parts.

# Individual Accountability

- Each member is accountable for the complete final outcome (ex., everyone must be able to explain the strategies used to solve the problem).
- To enforce:
  - ❖ small teams
  - ❖ individual tests
  - ❖ structure work like jigsaw puzzle
  - ❖ personal note books
  - ❖ call randomly on students to explain team's solution

# Forming Teams:

## Base vs. Informal

- **Base** or formal groups: formed in the beginning of the course to provide a comfortable, family-like environment for performing the various tasks.
- **Informal** groups: formed any time to practice working with others outside the base group and promote a strong feeling of cooperation across the entire class.

# Forming Teams: Large vs. Small

Large teams, **pros**:

- Larger range of:
  - expertise
  - abilities
  - skillswithin the group.
- Greater # of minds acquiring + processing info
- Greater # of hands available to do various tasks

# Forming Teams:

## Large vs. Small ( cont' d )

**Cons:** Large teams require advanced social skills to

- Provide everyone a chance to speak.
- Coordinate the actions of group members.
- Reach consensus.
- Ensure explanation and elaboration of the material being learned.
- Keep all members on task.
- Maintain good working relationships.

Lack of these skills may cause breakdown of the team process!!

# Forming Teams:

## Large vs. Small ( cont' d )

Factors in deciding how many students per team:

- **Time available** : 2' s work faster than 3' s, etc.
- **Student experience** :
  - experienced : can handle larger groups
  - novice : need experience with small groups first
- **Complexity of the task / Volume of work** :
  - simple task - small group
  - complex task - larger group

# Forming Teams:

## Heterogeneity

- Enhances elaborate thinking
- Increases frequency of giving & receiving of explanations
- Encourages perspective taking
- Enhances social skills

Teacher forms the teams. **Mix :**

- abilities
- sexes
- personalities
- ethnic groups

# Face-to-Face Promotive Interaction

- Chemistry!
- Verbal interchange.
- Active participating.
- Mutual help and support.
- Encouraging.
- Explaining.
- Peer feedback.
- Increased productivity.
- Individual growth.

# Interpersonal Skills

- Encouraging (participation)
- Checking (method, results, understanding)
- Elaborating

Ability to

- Function in a team.
- Reach consensus.
- Defend own opinion while being respectful of others.
- See things from the perspective of others.

# Group Processing

## (Reflection on the Team Process)

**write down:**

- 3 things your team did well while working together.
- 1 thing each member did, which helped the team.
- 1 thing your team needs to improve, to be more efficient next time.

**3 min**

# Teacher as Facilitator

- Guide on the side* rather than sage on the stage.
- Monitor groups. Make sure everyone is working and performing within their roles.
- Answer questions that cannot be answered within the groups.
- If a team is moving in the wrong direction, set them straight!
- Help with conflict resolution.

# Why should we use CL?

Discuss in your team and come up  
with as many reasons as you can!

2 min

# Why use CL ?

## Because we retain:

- 10 % of what we **read**
- 20 % of what we **hear**
- 30 % of what we **see**
- 50 % of what we both **see + hear**
- 70% of what we **discuss** w. others
- 80% of what we **experience** personally
- 90% of what we **say as we do something**
- 95% of what we **teach** someone else

*William Glasser*

*Stice, 1987*

*Dale's Cone of Learning, 1969*

**Bonwell & Eison, 1991**

*The exclusive use of lecture  
in the classroom  
constraints  
students' learning"*

# Why use CL ? ( cont' d )

- ❑ People learn better when working with each other vs.
  - ✓ Working in isolation
  - ✓ Competing against each other.
- ❑ Students practice team skills & small group communication skills, both essential in the workplace.

**John D. Rockefeller**

*I will pay more for the ability  
to deal with people than any  
other ability  
under the sun.”*

# Effects on Student Learning (faculty perspective)

Prior to using CL, I was becoming more and more familiar with the subject but the majority of the students were not. Now we all are.

*Chemical Engineering professor*

# Effects on Student Learning (student perspective)

One of the things I enjoyed most in this course was the more challenging group problems we did in class. Working in groups, if done correctly, can cut down on the learning time by a significant amount.

*ME 111 student (Fluid Mechanics)*

# Why use CL ? ( cont' d )

- ❑ Less stress / anxiety than competitive mode of teaching.
- ❑ Frequent feedback by instructor and peers.

# Why use CL?

- ❑ Increases faculty instructional productivity. (Johnson D.W., Johnson R.T., Smith K.A.)
- ❑ Promotes higher order thinking skills. (Johnson D.W., Johnson R.T.)
- ❑ Improves student retention. (Tinto, V.)  
(Astin, A.)

*“In a reasonable university course, you don’t expect students to copy down and repeat whatever you say; you expect them to tell you when you’re wrong or to come up with new ideas, to challenge, to pursue some direction that hadn’t been thought of before. That’s what real education is at every level, and that’s what ought to be encouraged. That ought to be the purpose of education. It’s not to pour information into somebody’s head, which will then leak out but to enable them to become creative, independent people who can find excitement in discovery and creativity at whatever level or in whatever domain their interests carry them.”*

Noam Chomsky, The Death of American Universities, Reader’s Supported News, 30 March 15

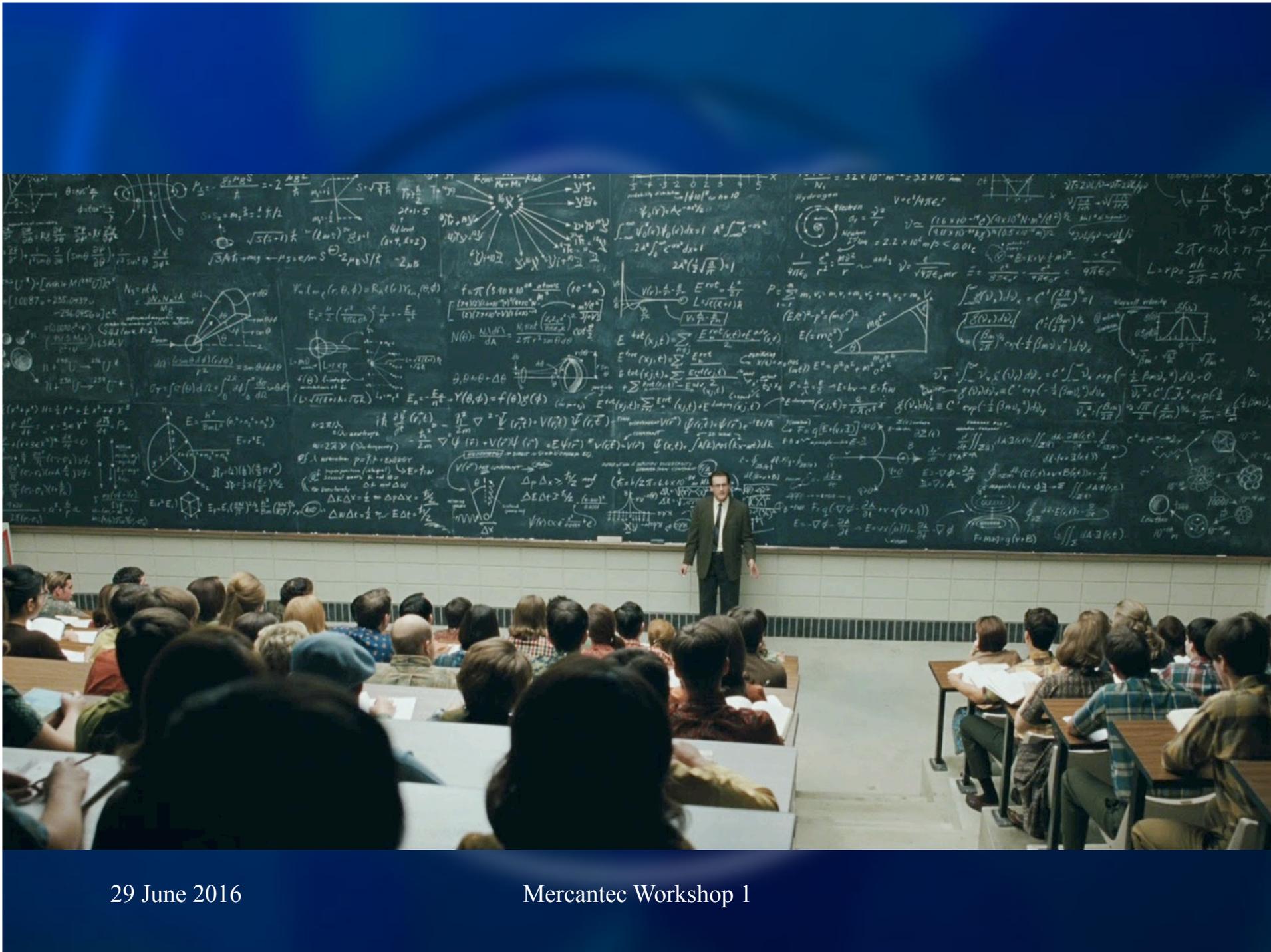
# What are some of the challenges in implementing CL?

Discuss in your team and come up  
with as many challenges as you  
can!

2 min

# Challenges with CL

- ❑ Competitiveness inherent in some fields.
- ❑ Commuter campus / lack of community.
- ❑ Free riders / unprepared students.
- ❑ Airline cabin syndrome (classroom arrangement).



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# How can we overcome these challenges ?

Discuss in your team and come up with as many ways as you can!

2 min

**Setup classrooms in a way that signals to students that DURING CLASS, they are expected to:**

**(a) Work and learn**

**(b) Collaborate with other students**



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# Reflection on the workshop

- The most interesting thing you're taking away.
- One thing you're ready to try.
- Unanswered questions ?

2 min