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 Problem
First Course Design Experience
UMN – Institute of Technology

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

Problem-Based Learning
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.
Team Member Roles

• Observer/ Process Recorder
• Task Recorder
• Skeptic/Prober
Technical Estimation Exercise

TASK:

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

COOPERATIVE: Improved Estimate (15 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.
HOW TO MODEL IT

PROBLEM SOLVING FOR THE COMPUTER AGE

Anthony M. Starfield ■ Karl A. Smith ■ Andrew L. Bleloch

CONTENTS

1 Introducing Models (and this book)
   A model of this book, showing how it differs from most books.

2 Time for Ping-Pong?
   How approach and solutions depend on resources.

3 Purging a Gas Storage Tank
   Using heuristics and tools such as spreadsheets.

4 The Case of the Hot and Thirsty Executive
   Interpreting results and presenting solutions.

5 Tennis, Anyone?
   Introduction to decision making under risk; probability and stochastic
   modeling.

6 Food for Thought
   The importance of organizing and representing information.

7 The Student’s Dilemma: French, Calculus, Time, and Money
   A resource allocation problem. Introduction to optimization.

8 A Cab Control System
   Using models to explore system dynamics. Modeling and design.

9 The Case of the Dishonest Advertiser
   Developing and comparing strategies: exploring trade-offs.

10 The Librarian’s Dilemma
    Qualitative knowledge models. Expert systems.

This active learning book has been used by high school students, in both
undergraduate and graduate classes; in engineering, business, science
and education as well as in professional development workshops.
Problem-Based Learning

- Problem posed
- Identify what we need to know
- Learn it
- Apply it

START
Subject-Based Learning

Given problem to illustrate how to use it

Told what we need to know

Learn it

START

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.
Problem-Based Learning (PBL)

Problem-based learning is the learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process – Barrows and Tamlyn, 1980

Core Features of PBL

• Learning is student-centered
• Learning occurs in small student groups
• Teachers are facilitators or guides
• Problems are the organizing focus and stimulus for learning
• Problems are the vehicle for the development of clinical problem-solving skills
• New information is acquired through self-directed learning
Group Processing
Plus/Delta Format

Plus (+)
Things That Group Did Well

Delta (∆)
Things Group Could Improve
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
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.
Modeling Resources


• Redish, E.F. and Smith K.A. 2008. Looking Beyond Content: Skill Development for Engineers. Journal of Engineering Education Special Issue,


