Learning Physics Through Problem Solving at the University of Minnesota

Course Structure
Three hours each week, sometimes with informal cooperative groups. Model constructing knowledge, model problem solving framework.

One hour each Thursday — cooperative groups practice using problem-solving framework to solve context-rich problems. Peer coaching, TA coaching.

Two hours each week — same groups practice using framework to solve concrete experimental problems. Same TA, Peer coaching, TA coaching.

Discussion Section (50 minutes)
1. A context-rich problem is distributed.
   - Topic previously modeled in lecture
   - Problem per section
2. Students work in groups to solve problem
   - Groups of 3 or 4 assigned by TA
   - Groups per section
   - Cooperative group structure
   - Groups change after each quiz (~3 weeks)
3. TA coaches each group.
   - A group, working on problem
   - TA decides which group to coach
   - Each coaching intervention less than 5 minutes
4. TA assigns a representative of each group to put a section of their solution on board.
5. TA leads a short (~10 minutes) discussion focused on work on the board.
6. TA collects problems and hands out complete solution to each student.
   - Only 1 solution per group
   - Problem solutions are graded only for group part of quiz (~every 3 weeks)

Laboratory Section (2 hours)
1. To attend each week's laboratory.
   - Student must pass a web quiz on assigned text reading
   - Usually (Laboratory) problems context-rich assigned per section
2. Each group discusses individual predictions and arrives at a group prediction for each problem.
   - Some group in discussion section
   - Cooperative group structure
3. TA assigns a representative of each group to put the predictions of each problem on the board.
4. TA leads a short (~15 minutes) discussion.
   - Compare and contrast predictions
   - What is the physics behind each prediction
   - What assumptions have been made
   - Correct answer is not given
5. Students use equipment to test their predictions.
   - Lab manuals are allowed
   - Text books are allowed
   - Notes are allowed
6. TA coaches each group.
   - TA observes groups working on problem
   - TA decides which group to coach
   - Each coaching intervention less than 5 minutes.
7. TA assigns a representative of each group to put a section of their results on board.
8. TA leads a short (~10 minutes) discussion focused on work on the board.
9. At the end of a topic (~3 weeks) TA assigns each student to hand in a lab report.
   - Each student in a group reports on a different problem
   - Reports are short (~4 pages) technical memos

Characteristics of Cooperative Groups
- Positive Interdependence
- Face-to-Face Interaction
- Individual Accountability
- Explicit Collaborative Skills
- Group Functioning Assessment

Details available at http://groups.physics.umn.edu/physed/

Supported in part by NSF, EPSCoR, and the University of Minnesota

A Problem Solving Framework

Context Rich Problems
- Each problem is a meaningful situation in which the major character is the student.
- The problem statement uses the personal pronoun "you".
- Decisions are necessary to proceed.
- The problem statement includes a plausible motivation or reason to calculate something.
- The objects in the problems are real (or can be imagined) — the student provides the idealization.
- No pictures or diagrams are given with the problems. Students must visualize the situation by using their own experiences.
- The problem can not be solved in one step by plugging numbers into a formula.

Examples of Context-Rich Problems
1. You have been hired as a technical advisor for the police to help in the scientific investigation of a crime. A shooting happened in an apartment but the people in a neighboring apartment claim that they did not hear a shot. You have been assigned to see the physical evidence to determine if they are telling the truth.
2. You are helping a friend design a pendulum clock for a class project. The timing mechanism for the clock is a 0.75 m long metal bar pivoted at its end. The period of the pendulum is adjusted by means of a small lead ball attached to the bar so that it can be moved. The mass of the ball is the same as the mass of the bar. Your friend has asked you to determine the position of the ball along the bar that will give a period of 2.0 seconds when the bar swings.

Introductory Physics for Science and Engineering (1301) – Force Concept Inventory 1994-2005
12 years of using Cooperative Problem Solving

Introductory Physics for Science and Engineering

H, F94
D, F95
I, F95
E, F94
F, F94
L, F95
Y, F04
Y, F03
M, F96
M, F99
M, F00
O, F99
Q, F00
K, F99
K, F01
U, F02
K, F02
X, F04
U, F04
N, F00
N, F97
D, F97
M, F96
X, F04
Y, F03
M, F99
M, F00
O, F99
Q, F00