“Half and Half” Homework

Can *peer instruction* methods

be adapted to *physics homework*?

American Association of Physics Teachers
New York State Section
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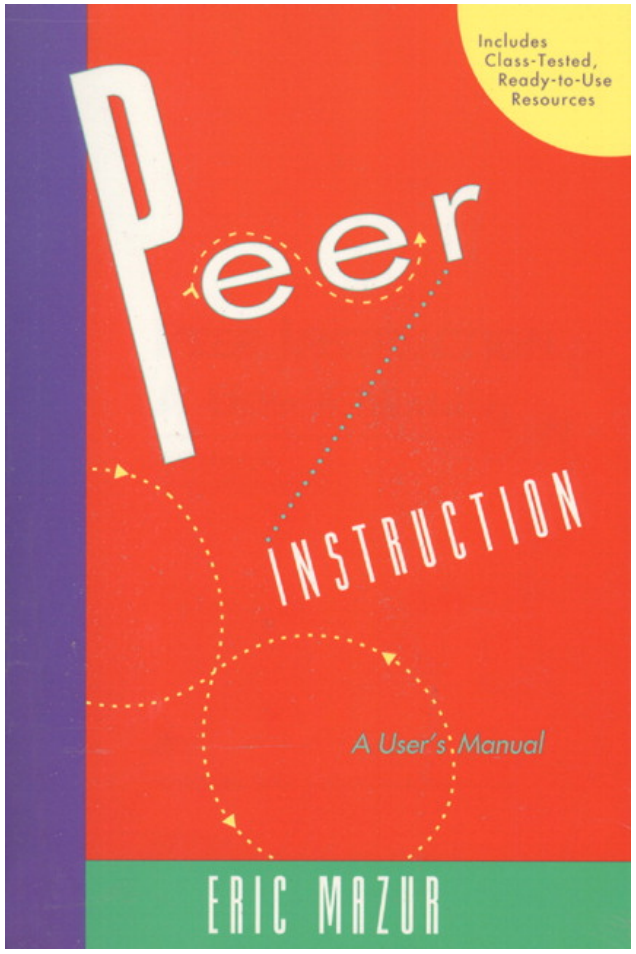
Peer Instruction in Physics



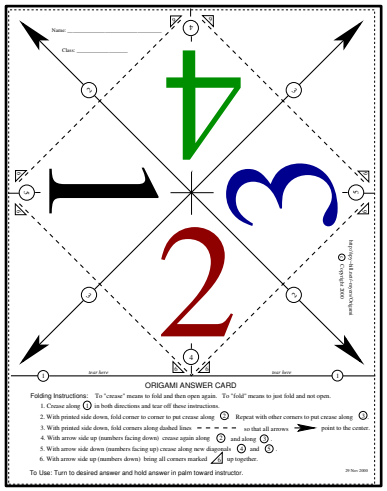
Eric Mazur of Harvard created a collection of "*ConcepTests*", which are simple but challenging conceptual questions.

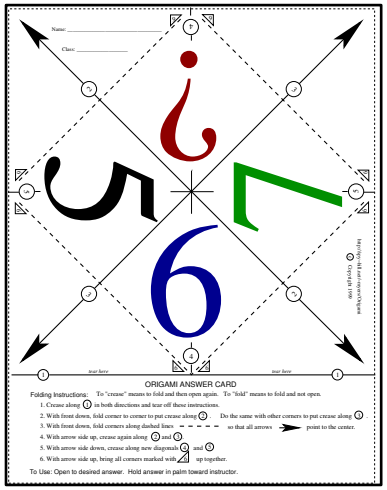
Usage:

1. Present the question to the class and ask for "first guess". No pressure to get it right.
2. Then ask them to talk to their neighbors to compare answers and reasoning. Let them chat for 60 sec or so.
3. Then ask for the "Final Answer"
4. You can reveal the answer and then explain it, or talk through the solution to get to the answer.
5. Optionally, ask a student who changed their answer to explain why. But always give the teacher's explanation as well.

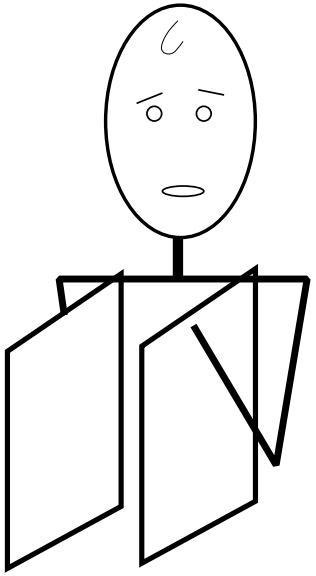
Many textbooks now include "clicker questions" -- I've also created my own

Example 1:





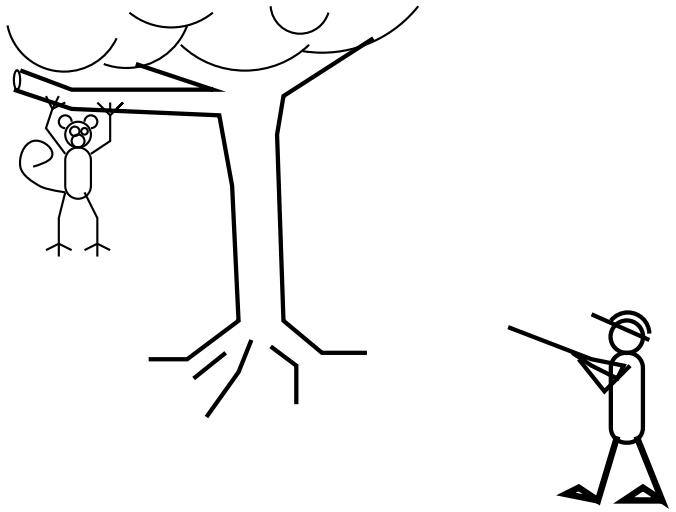
I hold two pieces of paper so that they hang vertically in front of my face, with an inch or two between them.



If I blow between the pieces of paper, what happens?

1. They move apart
2. They stay where they are
3. They move closer together
4. I look pretty silly

Example 2:



A hunter fires his gun at a monkey which is hanging from a tree branch. The monkey, upon seeing the flash of the gun, lets loose of the branch and falls toward the ground. The hunter's bullet

1. passes above the monkey
2. hits the monkey
3. passes under the monkey

View demonstration on YouTube

http://www.youtube.com/watch?v=cxvsHNRXLjw

Example 3:

A boat is floating in a lake. A heavy rock, which was originally inside the boat, is thrown overboard and sinks to the bottom.

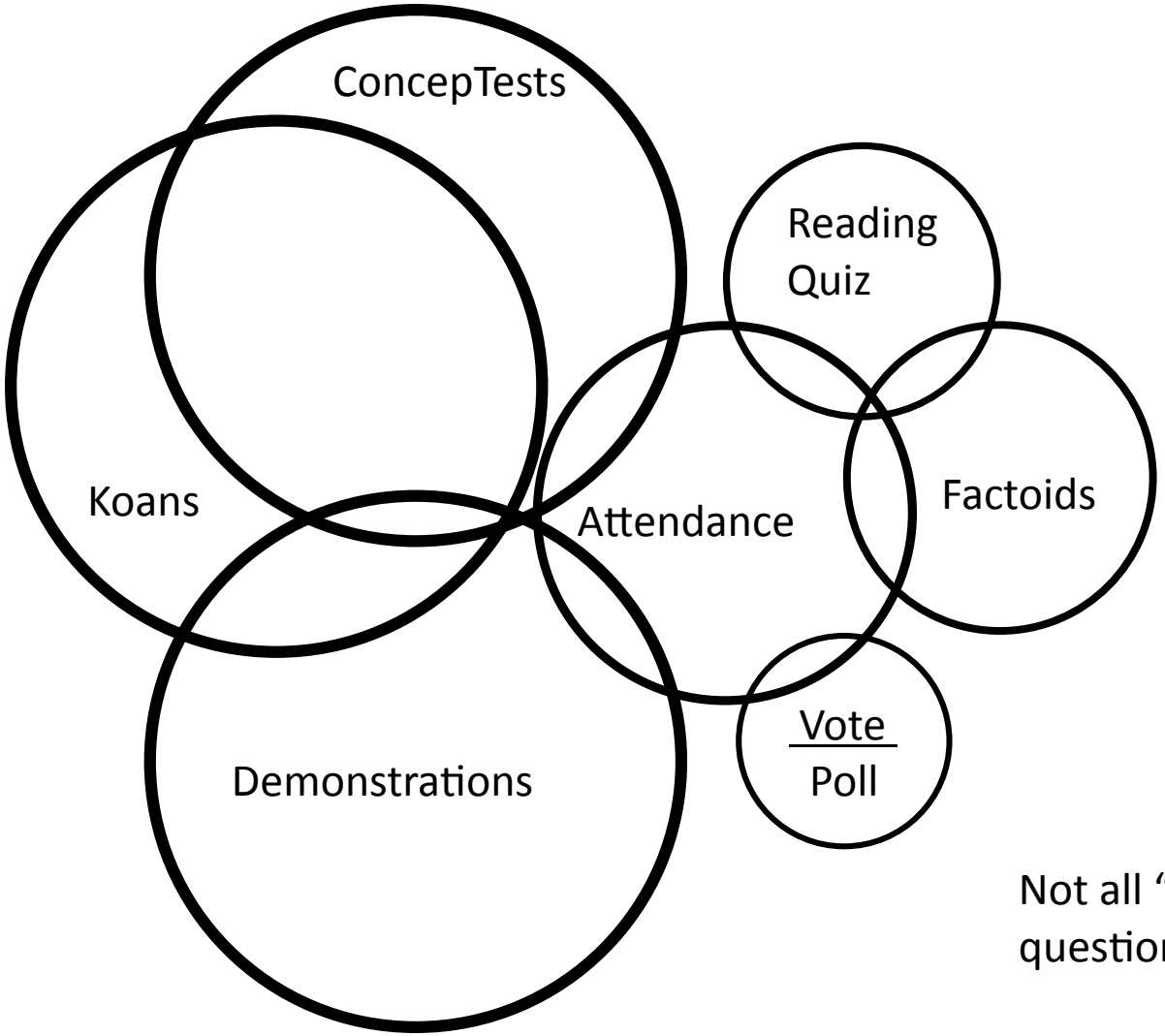
What happens to the level of the water in the lake?

1. It increases slightly.
2. ~~It stays exactly the same.~~
3. It decreases slightly.

Originally the rock was an anchor. One day a student asked

"is the anchor resting on the bottom, or hanging from the boat?"

“Clicker” Questions



Not all “clicker” questions are koans

Physics Kōans

In Zen Buddhism a *kōan* is a story, question, or statement which may cause initial puzzlement, but which leads to enlightenment with further thought and reflection.

"What is the sound of one hand clapping?"

A *physics kōan* is a conceptual question that is puzzling at first, but which illuminates or demonstrates physics principles or ideas or concepts.

The choices for answers are generally distinct differences: does it go up, or go down, or stay the same?

Or they may be based on common misconceptions.

Or they may be predictions for the outcome of demonstrations.

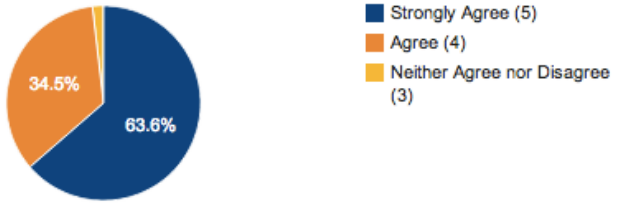
Good physics kōans use and illustrate the application of principles, rather than just memorization.

Student Reactions

Student Evaluation of Instruction
Physics 201 - Spring 2013

18. The demonstrations -- objects or devices brought into class -- made a valuable contribution to the course.

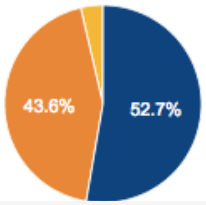
Responses: **55/55 (100%)**
Mean: **4.62**
Standard Deviation: **0.53**



Demonstrations:
98.1% positive

15. The graded homework (Problem Sets) made a valuable contribution to the course.

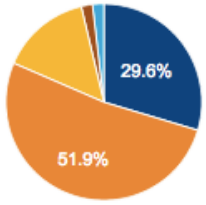
Responses: **55/55 (100%)**
Mean: **4.49**
Standard Deviation: **0.57**



Graded Homework:
96.3% positive

14. The conceptual questions in class (the "physics koans") made a valuable contribution to the course.

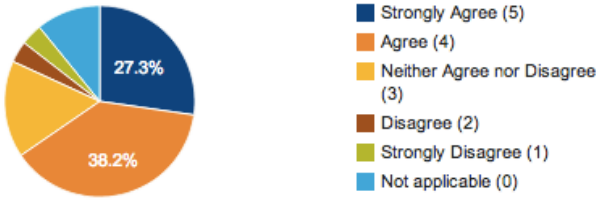
Responses: **54/55 (98%)**
Mean: **4.04**
Standard Deviation: **0.91**



Koans:
81.5% positive

16. The ungraded homework (Assigned Problems) made a valuable contribution to the course.

Responses: **55/55 (100%)**
Mean: **3.49**
Standard Deviation: **1.56**



Ungraded Homework:
65.5% positive

The Big Question…

This kind of peer instruction works in the classroom because the questions are straightforward (but not obvious) and can be reasoned out easily in a brief time based on basic principles, which have usually just been presented.

Can peer instruction be extended to homework?

In Praise of Homework

Homework is an important part of learning physics!

Levels of Learning
1. Rote
2. Understanding
3. Application
4. Correlation

Homework provides…

- practice using new methods
- widened variety of examples
- confrontation with tricky parts
- active application, not just passive understanding
- a source for “personal examples”
- a cross-check on learning
- practice for the exams

The Homework Process

-- How everybody thinks it works

Read problem statement

↓

Attempt solution

↓

Are you stuck?

No ↓

Obtain answer

↓

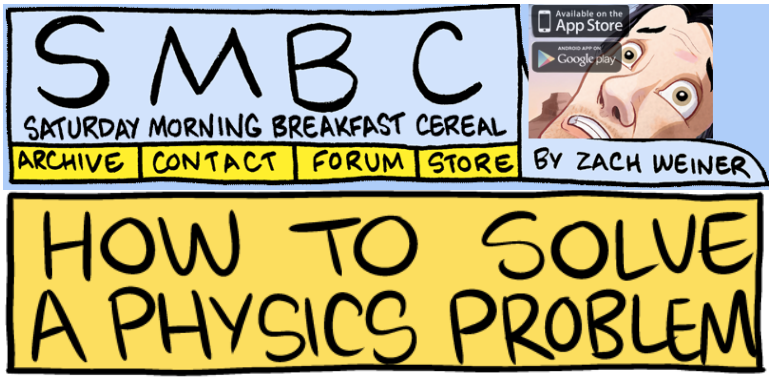
Is it correct?

Yes | *Can't tell*

↓

Done!

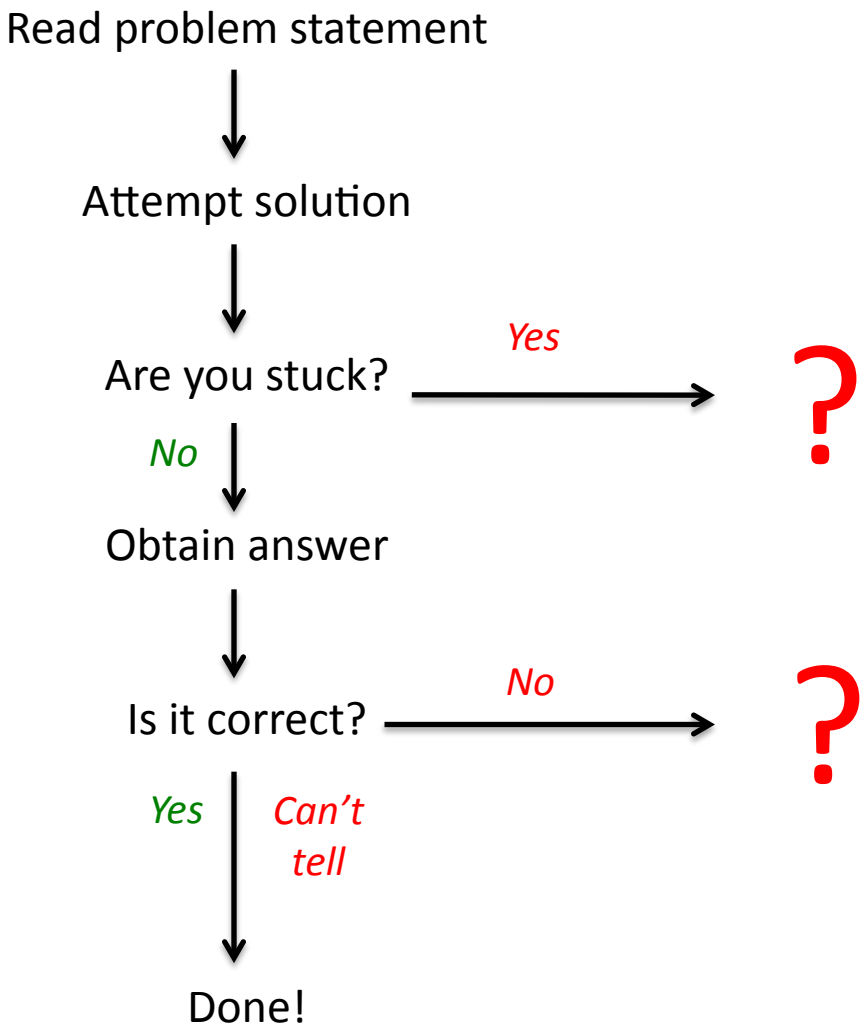
(How it often works)



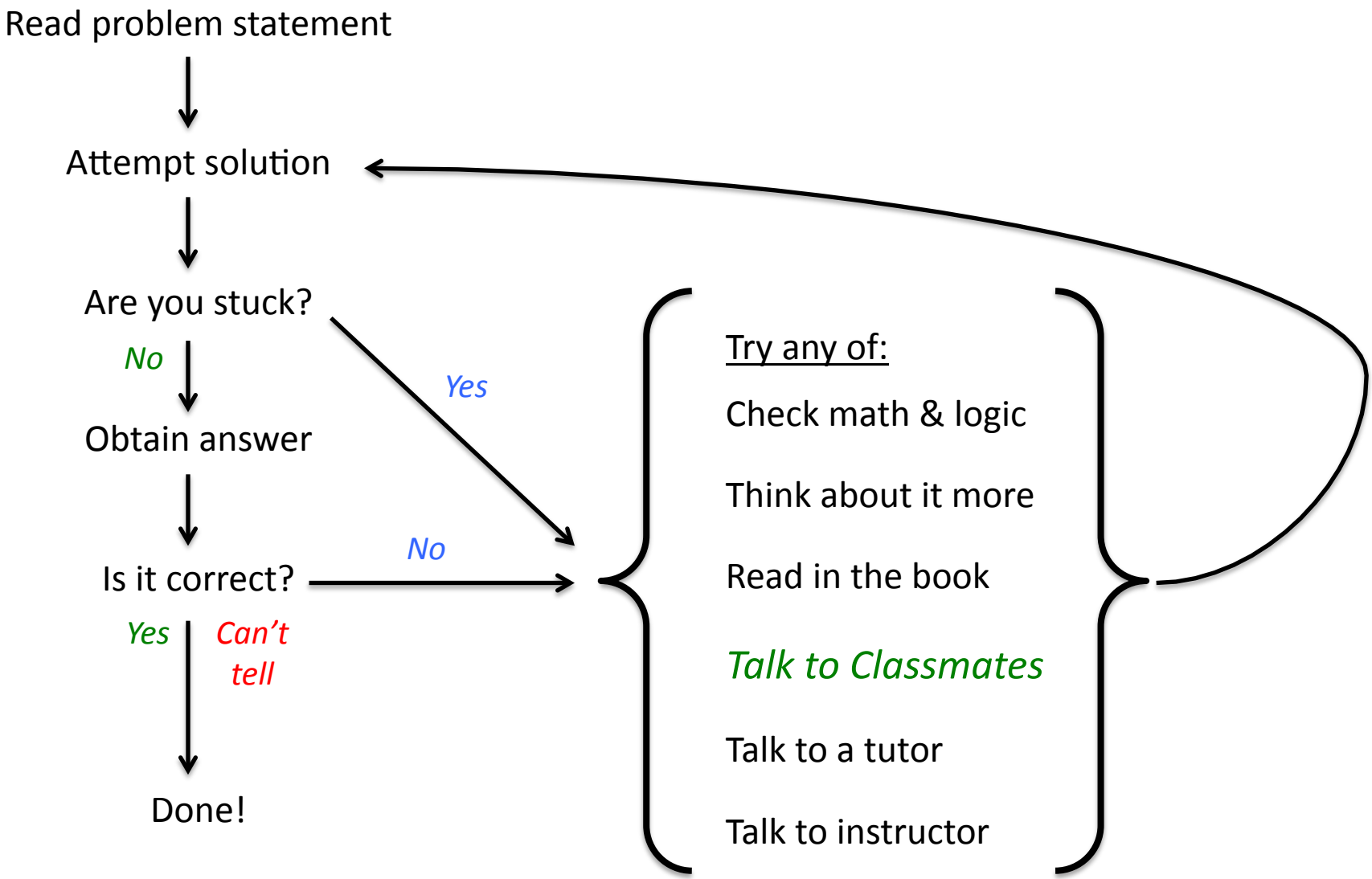
http://www.smbc-comics.com/index.php?db=comics&id=3011#comic

The Homework Process

-- The straight path doesn't work!



The Homework *Cycle* -- How one really *learns* from homework



Prior ways to focus on homework

- Keller Method
  - No Lecture. Students read chapter/unit and work homework problems.
  - Meet in small groups with tutor to ask questions and discuss homework
  - Unit test requires 70% or better to proceed (else try again another day)
  - Hourly and Final exam scores determine grade
- Flipped Classroom
  - No in-class lecture. Students view video outside of class.
  - Work homework during class time, ask questions and get help from instructor
- On-Line homework systems
  - Student works homework problem and enters answer
  - Correct answer means probably correct solution
  - Incorrect answer: give hints or suggestions / show relevant part of textbook
  - Try again - possibly several times
  - Grades could be scores, completion, or ignored

"Half-n-half" Homework

How can we incorporate peer interaction and peer instruction into the Homework Cycle?

The main idea:

1. Students work in pairs, to solve two homework problems, both based on the same concepts or principles. (a *"couplet" or "Entangled Pair"?)*

2. Each student knows of only one of the problems, and is charged with both a) obtaining the solution, and b) being able to explain it to someone else.

3. The students meet, and each teaches the other how to do their problem.

4. Students then submit solutions to both problems for grading, or enter answers in an on-line system (on-line systems can give different numerical values even for same problem).

5. (Optional) One student's grade is based in part on how the other student did on the problem.

Pros and Cons

Pros:

1. Peer instruction: explaining to others leads to deeper learning

   "See one, do one, teach one"

2. Peer instruction: chance to discuss with someone with same background

3. Just gets students talking with each other -- about physics

4. Could add personal interactions to on-line courses (or MOOC's)

Cons:

1. Scheduling could be complex, with little gain. Computer programming may be required.

2. Students could get around it by sharing problem numbers before meeting.

3. Or they can share the answers (unless using "algorithmic" on-line system)

To Do List

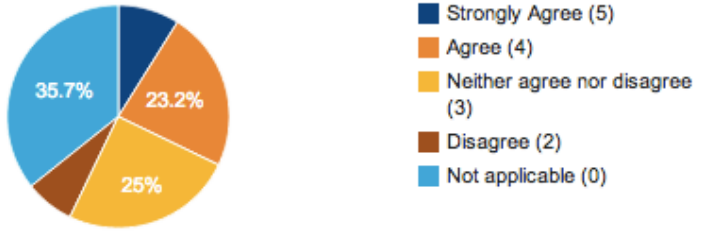
1. Learn more about on-line homework systems:

   In the last two semesters we tried both WileyPLUS and the Sapling Learning on-line homework systems for the optional "Assigned Problems". This semester we've added WebAssign.

23. The on-line homework problems (either WileyPLUS or Sapling Learning) made a valuable contribution to the course.

Responses:	55/55 (100%)
Mean:	2.27
Standard Deviation:	1.84

32.1 % positive
35.7 % not applicable
(50 % positive when applicable)



2. Identify appropriate pairs of problems

   Halliday, Resnick, and Walker textbook 9th Edition has same problems as 8th Edition, but moved around. Interchanged problems are similar and often make good "couplets"

To Do List…

3. Find best way to structure assignments:

   Balance overall point value but not individual problems

4. Find simple ways to test at least parts of the whole

   Last semester we tried the following:

   - Divide the class into two groups: Team A and Team α
   - Separate assignments given to each first, with some overlap.
   - All problems revealed later on, so it's just a head-start
   - Solutions to all problems revealed before exam

MOOC's: Massive Open On-line Courses

Trying to teach complex topics such as physics or mathematics only via the Internet is like Thisbe teaching calculus to Pyramus through a small hole in a wall.

luna-wannabe @deviantart.com

Half-n-half homework could get them together, face to face, on the same side of the wall (provided we can avoid the lions).