ConcepTests for Introductory Astronomy

Paul J. Green
Smithsonian Astrophysical Observatory
at the
Harvard-Smithsonian Center for Astrophysics
TYPICAL ASTRO 101:

- large (>100 students)
- Earth to Cosmos in one semester
- phenomenological not conceptual
- well-practiced lectures, heavy on AV, graphics
- multiple choice exams emphasizing recall
- competitive grading discourages student interaction

GETTING STUDENTS UNINVOLVED!

- numbing blizzard of rules and facts
- critical thinking not engaged
- science by authority not adventure
- social/collaborative nature of science lost
- no personal stake
CLASS IMPLEMENTATION

An Example of Peer Instruction

http://hea-www.harvard.edu/~pgreen/educ/PI.html

- *First class*: gauge student background and prior knowledge. Prepare them for conceptual class mode.

- Reading quizzes: encourages reading before class, and dispenses with the factoids.
CLASS IMPLEMENTATION

An Example of Peer Instruction

- Lecture briefly in ~standard format on one of the fundamental concepts to be covered.
- Present a ConcepTest: a short multiple-choice question tests students’ understanding.
- After 1 minute, the students record an answer and are asked to turn to their neighbors to try and convince them of their answers.
- 3 minutes for discussion and reconsideration, then each records a (new?) answer.
- A quick tally decides whether to stay on this concept, or move on.
BENEFITS OF CONCEPTESTS

- Emphasize conceptual over rote learning.
- Emphasize student involvement in the learning - and scientific - process.
- Engage student ego and attention.
- Provide student self-gauging.
- Provide real-time student/instructor feedback.
- Anticipated misconceptions challenged, unanticipated misconceptions unearthed.
- Extensive documented success in Intro Physics!
ASTRONOMY CONCEPTTEST DATABASE

Source 1: Instructor/Collaborators

Access Limitation
- increases the database
- prevents student access
- increases instructor participation
- facilitates evaluation, attribution, and modification

Currently:
- 20 questions makes you a collaborator
- about 300 questions now on-line, organized by topic

ASTRONOMY CONCEPTTEST DATABASE

Source 2: Quiz Genie
- Instructor clicks on topics of interest from a searchable menu (≈ 20 topics, 250 subtopics)
- Genie generates and displays multiple choice questions, answers highlighted.
- Questions recommended for ConcepTests are highlighted.
- Instructor selects desired questions.
- Genie returns an exam with headings.

Currently:
- ≈5,000 questions each cross-indexed by subtopic (246 total)
- Seeking Java programmer

<table>
<thead>
<tr>
<th>question</th>
<th>asked of 1009 students</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>74.5% right</td>
</tr>
<tr>
<td>Number of answers</td>
<td>22.8% wrong</td>
</tr>
<tr>
<td>CAV 5</td>
<td></td>
</tr>
</tbody>
</table>

If the force of the sun’s gravity were suddenly turned off

*) the earth would continue to move, but in a straight line
1) the earth would move directly away from the sun
2) the earth would stop moving
3) earth would spiral around sun at increasing distances
4) None of the other answers is correct

>> NEWTN GRAV ACCEL

List of relevant subtopic codes
A HANDFUL OF REFERENCES
for Peer Instruction and ConcepTests

- Paul Green’s Peer Instruction for Astronomy HomePage:
  http://hea-www.harvard.edu/pgreen/educ/PI.html
  and Astronomy ConcepTest Database
- Eric Mazur’s Physics Peer Instruction HomePage:
  http://mazur-www.harvard.edu/Education/EducationMenu.html
  and its implementation
  http://physics11.harvard.edu/center.html
- Implementation at Eastern Michigan University:
  http://www.emich.edu/public/fcie/usingpeerinstruction.html
- ConcepTests for Chemistry and Implementation at Wisconsin:
  http://www.chem.wisc.edu/concept/

PUBLICATIONS:

- P. M. Sadler 1992, “The initial knowledge state of high school astronomy students”, Dissertation, Graduate School of Education, Harvard University