Active classes in eosc355 The Planets
a 3\textsuperscript{rd} yr science elective course
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• Who’s takes the course?

• Focus on in-class worksheet activities:
  – Context & learning goals
  – In-class pattern of work
  – Examples
  – Assessments
  – Lessons learned

Demographics

\begin{tabular}{|c|c|c|}
\hline
Course & 2010 & 2009 \\
\hline
Life Sciences & &  \\
Chemistry & &  \\
Biol & &  \\
Biochemistry & &  \\
EOS / geoEng & &  \\
Phys / Astron & &  \\
Computer Science & &  \\
Other singles & &  \\
\hline
\end{tabular}
Worksheets in context

3rd / 4th yr Sci. elective

prerequisites: 1st yr sci. only

In-class Worksheets
Practice with ...
• observing / measuring
• modelling / applying
• questioning / communicating
• Inferring / deducing

Teams (TBL-like)
• Distributed reasoning
• Peer support
• Tutor-like guidance from instructor

Skills used in ...

Assignments (3)
• Solo
• Synthesis oriented

Projects (poster)
• 3-step deliverables, with feedback
• peer assessment

Midterms

‘Generic’ science skills

main goals

Learning Goals

Content

necessary backgnd

diverse sources & assessments

• Readings + quizzes
• Lecture + clickers
• Participation
• Diagnostic tests

Topics
• Orbital mechanics
• Surface features
• Interiors
• Atmospheres
Learning goals.

1. **Emulate the thinking** of specialists when addressing questions or hypotheses
   Refer to measurements & observations, existing knowledge, and accepted or proposed models.

2. Recognize relevant **assumptions & limitations** when dealing with **models and data**
   Recommend observations, further theory or model refinement that might improve the model.

3. **Estimate** basic whole-body parameters of any planet, moon, etc.
   Use relationships between parameters and data describing orbital and tidal motions.

4. Use observable surface features to **discuss models** of surface age & geological history.

5. Develop, articulate & discuss hypotheses about how **internal structure, dynamics and evolution** relate to **surface features, atmosphere, bulk properties, and magnetic fields**.

6. Pose a clear question, hypothesis or proposal regarding any aspect of planetary science, then research, communicate and debate current state-of-the-art in a scholarly manner.
Preliminaries:
- Readings (→ quiz)
- Goals in context
- (some params at home)
- (short lecture - clickers)

On Screen:
- color images
- question or task

Team folders
- worksheets, data, images, etc.

On Screen:

TA: assess, highlight misconceptions & strengths

Follow up options
- clicker questions
- image annotations
- teams contribute to discussions
- expert perspective
- intermediate results

Teams
- Self-regulated work

Instructor
- circulates; Socratic tutoring

Deliverable
- simple; e.g. marks on sketch

worksheet results

between classes

follow-up on intermediate results

work resolved
- same or next day

Analogous exam & assignment tasks

End
Some lessons learned

- Tutor Socratically — equal time for all teams
- Watch timing carefully
- **Start:** clarify goals & reasons
- **Finish:** always resolve work — refer to accomplishments (goals)
- **minimize** written instructions
- **minimize** output “product” (graphical deliverables are good)
- **maximize** reasons to discuss (e.g. avoid “right answers”)
- Work should be difficult to do solo
- Vary the teams’ spokespersons
- Cold-call by team via spokesperson

*(Many strategies based on TBL)*
1. Identify the major regions on the basis of crater densities and grayscale. On your image draw outlines of your regions, and label them, A, B, C, etc.

2. What are relative surface ages of your different regions (oldest to youngest?)

3. Identify major linear or quasi-linear features and mark these on your image.

4. Is feature X younger than feature Y? (X and Y labels are on the projector.)
1. Identify major regions on the basis of crater densities and grayscale

Followup using clickers.

How many did you find?

A. 1
B. 2
C. 3
D. 4
E. >=5
1. Identify major regions on the basis of crater densities and grayscale.

Discussion after clickers.
Teams highlight boundaries selected using laser pointer.
Evaluating effectiveness

- Testing results
  - Quizzes, midterm 1, midterm 2
- Assignment & project abilities
- Opinion surveying – questions about
- Challenges:
  - It takes several iterations to perfect an activity
  - Timing; end-of-activity resolution is crucial
  - Tutoring 12 teams in 12 minutes takes practice! A teaching assistant helps for >70 students.
  - Consider a ‘cold-calling’ procedure to enable team contributions to class discussions.

Colour coded Q #\'s
- teams
- learning goals
- quizzes / midterms
- projects
- "warnings"
- Instructor related
Example: assignment #2

- **Goal:** Test two hypotheses for Venus’ geological history using observations of cratering, volcanism and tectonism from radar images. Decide which of the hypotheses your observations best support.

- **Instructions include:**
  Data & resources ... procedures ... deliverables ... background

- **Tasks:**
  - Predictions of two hypotheses
  - Test both your predictions using images provided (observations & calculations)
  - Estimate ages of features (observations & calculations)
  - Synthesis: discuss which hypothesis is most well-supported.

- **Feedback:**
  - What was the most difficult part of this assignment and why? (1-5 sentences).
  - How long did you spend on the assignment (round to nearest hour)?

  Pin example here.
Example test questions  (paraphrased)

Imagine we have discovered Planet Z between Mars and the asteroid belt. Data or formulae for investigating planet Z are in the attached data sheet.

1. Which of these compositions can provide insight into the bulk composition of planet Z? Circle all that apply:
   1. A. Moon  
   2. Solar photosphere

2. Give ONE brief reason for EACH composition you selected above.

3. Etc ..... ( more than 50% of midterm #2 )
Example test questions (paraphrased)

Use this radar image of Venus for the next questions. Radar illumination is from the left.

1. Identify features A-G as tectonic, impact, fluvial, weathering or volcanic. Try to be as specific as possible.

2. Now take any lava flows you have identified plus lava flow C and list them in order of decreasing age.

3. Now look at any major crater(s) you have identified. What can you infer about the timing of the crater(s) relative to the lava flows?

4. Etc ..... (roughly 20% of midterm #1)
Midterm results:

Generally a good balance of difficulty.

Midterm #1 item analysis

Multiple choice and short answer

| Question #s | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|-------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Averages:   | 100 | 100 | 100 | 93 | 48 | 26 | 77 | 88 | 69 | 4  | 24 | 62 | 96 | 100 | 83 | 93 | 48 | 37 | 63 | 63 | 54 | 67 | 65 | 93 | 93 | 85 | 83 | 98 | 9  | 44 | 68 | 95 | 24 | 74 | 81 | 94 | 68 | 83 | 90 | 89 |
| bot 50%     | 100 | 100 | 78 | 78 | 63 | 31 | 9 | 40 | 72 | 69 | 13 | 11 | 41 | 81 | 94 | 25 | 84 | 66 | 41 | 75 | 16 | 86 | 28 | 14 | 48 | 56 | 36 | 41 | 31 | 84 | 80 | 63 | 50 | 92 | 9  | 13 | 68 |
| discrim     | 0 | 0 | -1 | 12 | 19 | 21 | 47 | 32 | 10 | -2 | 54 | 29 | 20 | 8 | 3 | 10 | 5 | 6 | 11 | 8 | 56 | 4 | 26 | 45 | 13 | 6 | 20 | 24 | 35 | 1 | 7 | 15 | 25 | 3 | 2 | 56 | 6 | 1 | 29 | 11 | 14 | 9 | 8 | 24 | 19 | 13 | 23

Midterm #2 item analysis

"Worksheet like"

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Green averages:
- Well done.

Green discrim:
- The question distinguishes top & bottom students

"Worksheet like"

Midterm2

Midterm1

Colour key:

- easy
- good discriminator
- lecture only

Is this distribution suitable for a 3rd or 4th year off-discipline science elective ??

You decide ….
Opinion surveying

• Feedback from 59 / 64 students

(pin survey results here)