Active classes in eosc355 *The Planets* a 3rd yr science elective course

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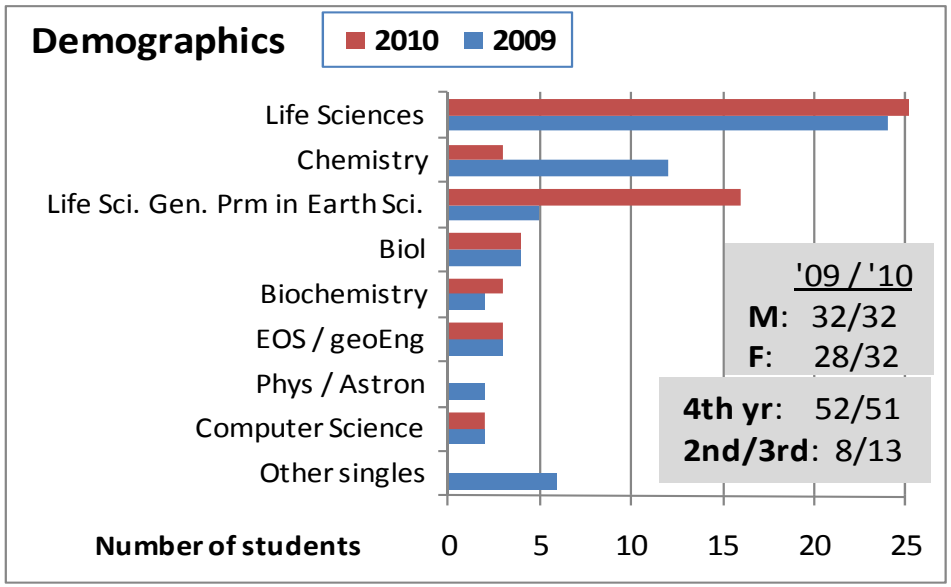
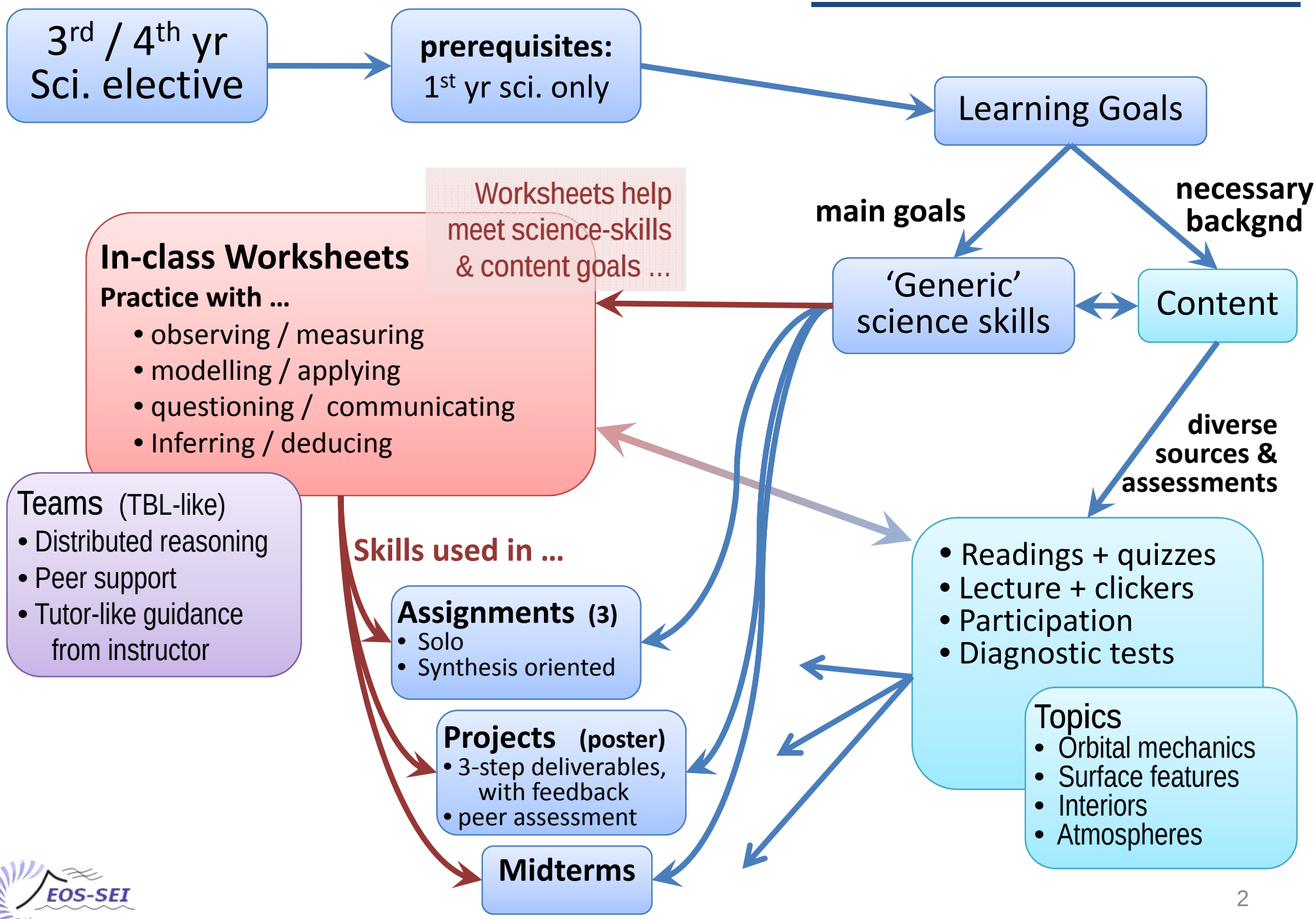
- Who's takes the course?
- Focus on in-class worksheet activities:
  - Context & learning goals
  - In-class pattern of work
  - Examples
  - Assessments
  - Lessons learned



Worksheets in context



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.

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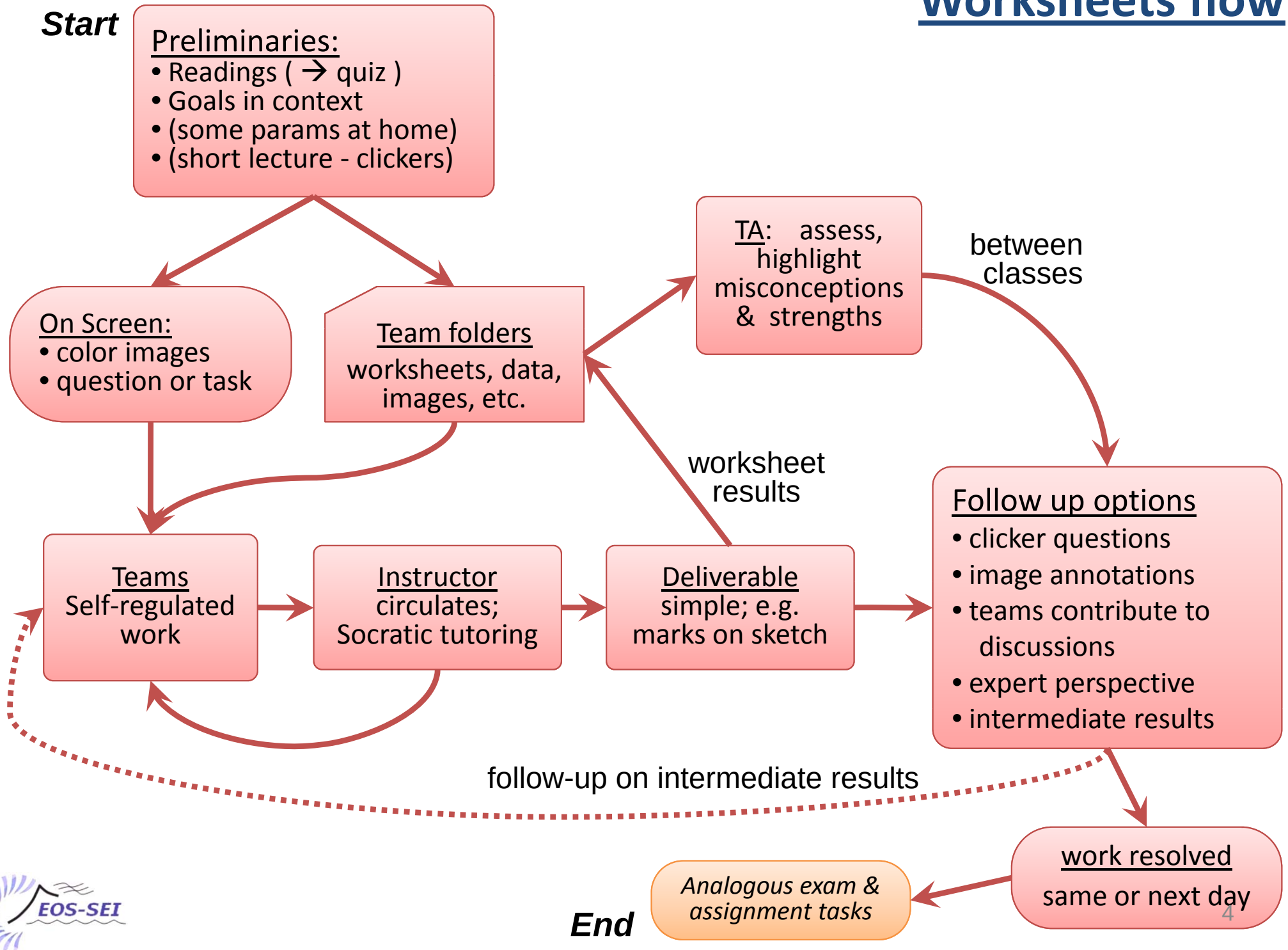
Worksheets flow



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)

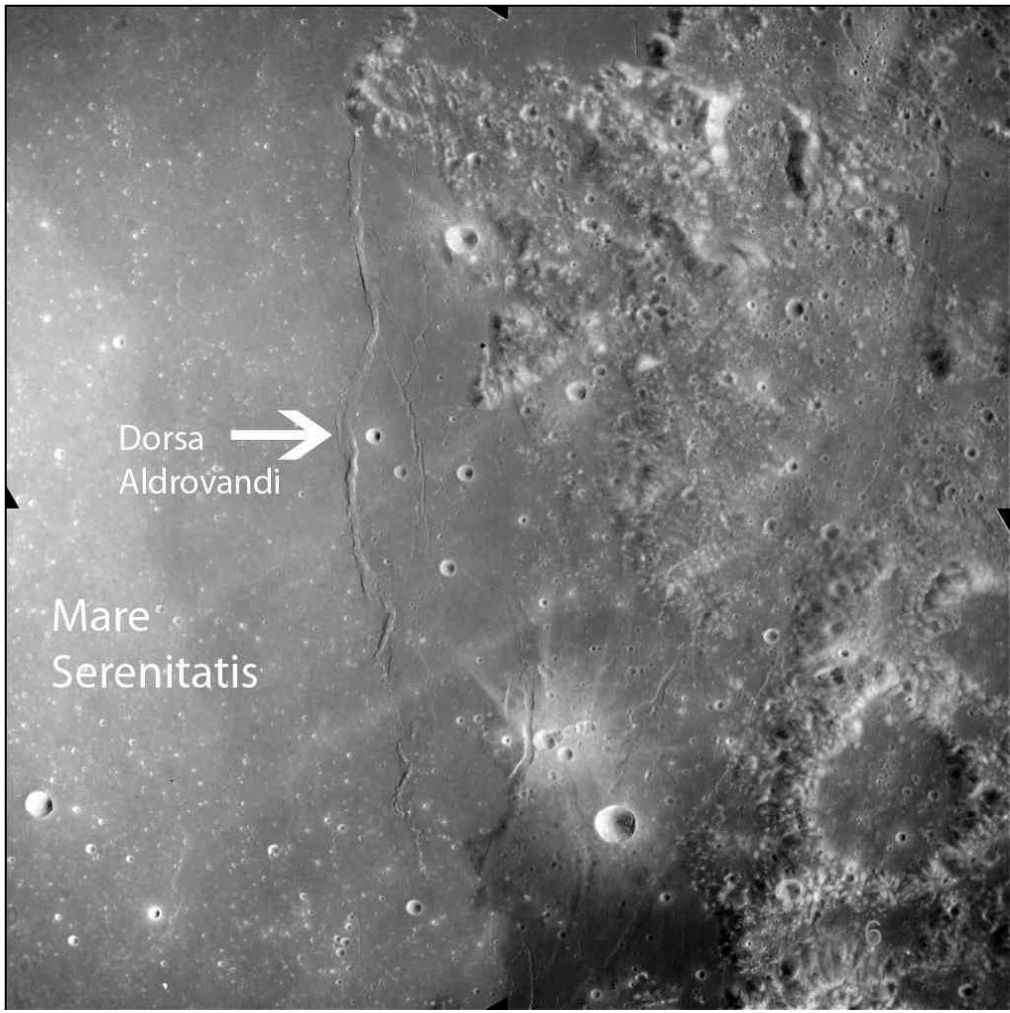
Example: near end of module2, week6.

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?

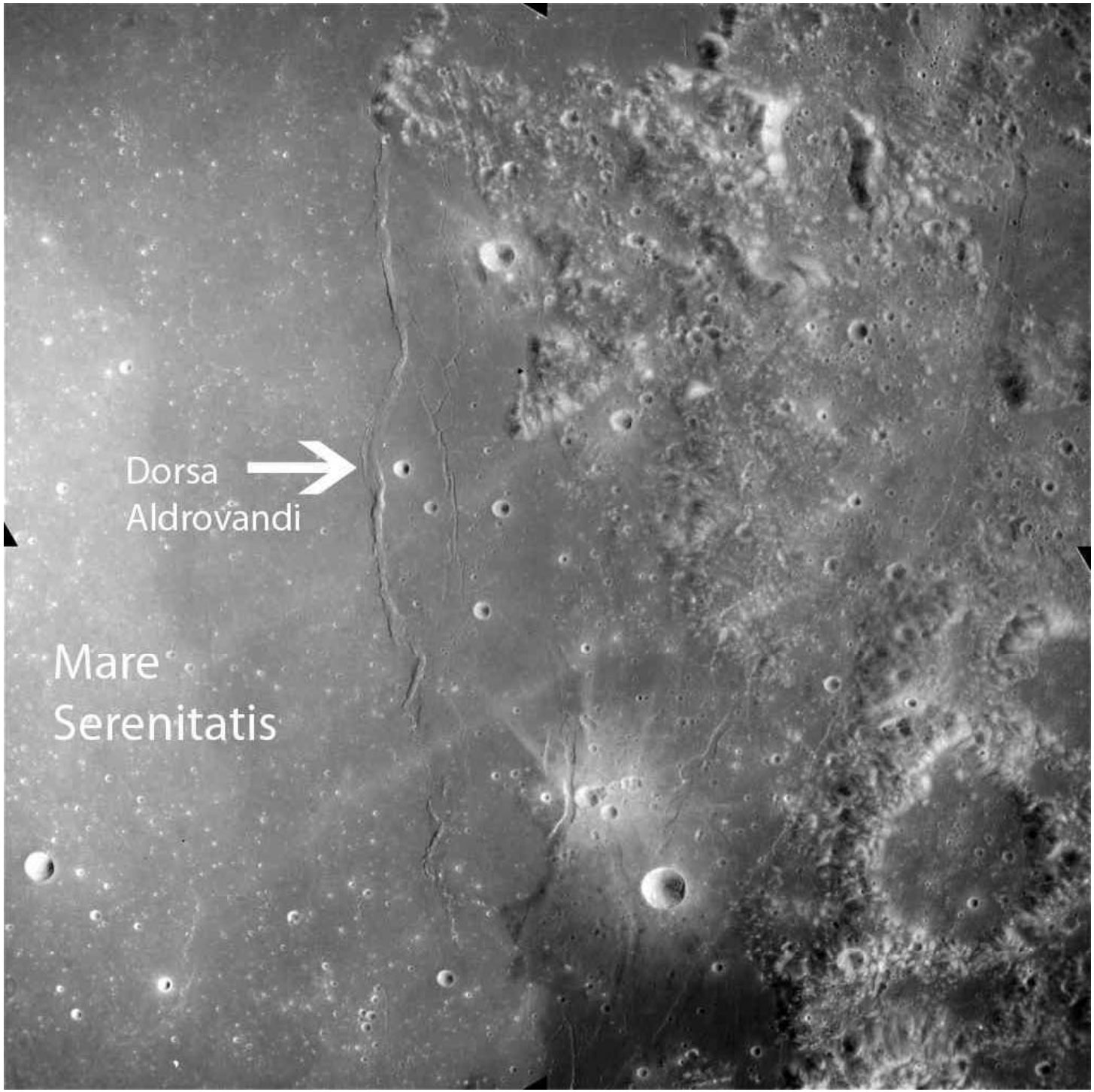
3. Identify major linear or quasi-linear features and mark these on your image.

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.



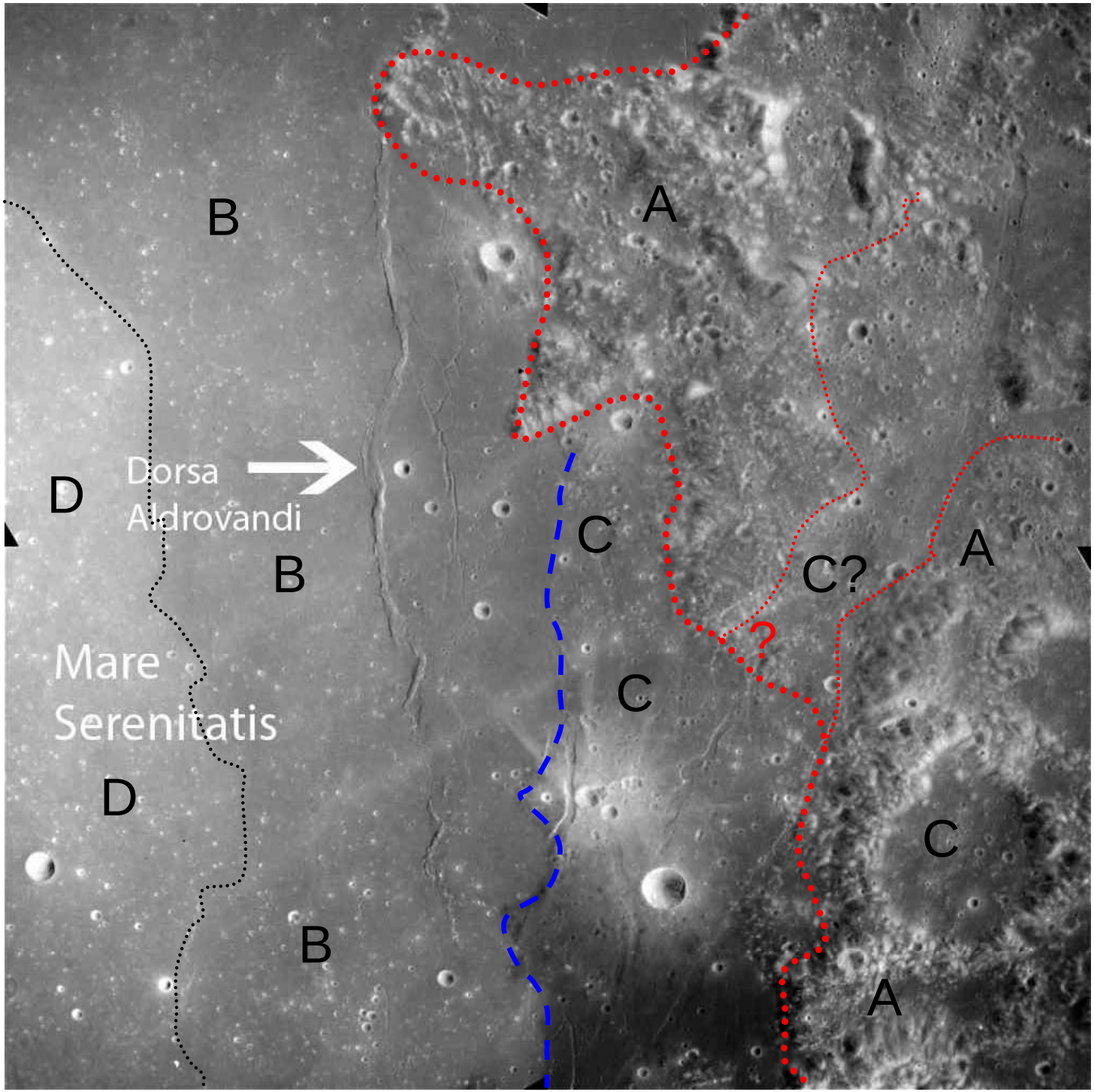
How many did you find?

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

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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.

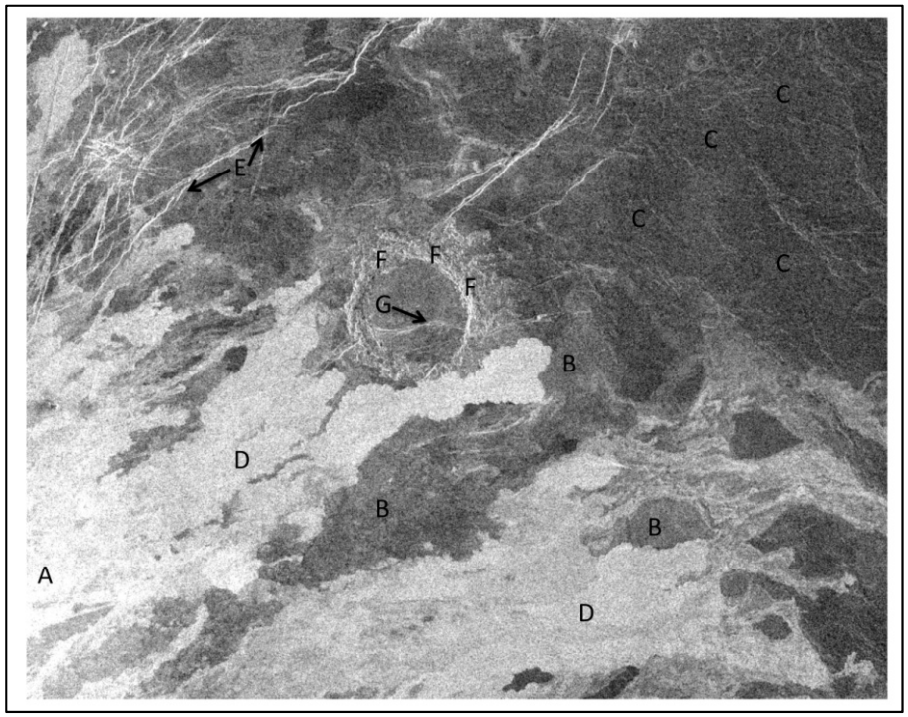
1. Which of these compositions can provide insight into the bulk composition of planet Z? Circle all that apply:
   1. A. Moon B. Earth C. Mercury D. Carbonaceous chondrite
   2. Solar photosphere F. Jupiter G. Galilean satellite

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

"Worksheet like"

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	39	40	41	42	43	44	45	46	47
Averages:																																																
top 50%	100	100	77	100	93		48	26	77	88	67	4	74	62	96	100	93	93	74	78	89	56	94	48	37	63	63	54	67	65	93	93	85	83	98	94	44	98	95	74	74	81	94	68	83	90	89
bot 50%	100	100	78	78	63		31	9	40	72	69	13	41	41	81	94	75	84	66	41	75	16	86	28	14	48	56	36	41	31	84	80	63	50	92	91	13	88	93	41	59	62	79	57	51	62	69
discrim:	0	0	-1	12	19		21	47	32	10	-2	-54	29	20	8	3	10	5	6	31	8	56	4	26	45	13	6	20	24	35	5	7	15	25	3	2	56	6	1	29	11	14	9	8	24	19	13

problematic *fairly easy* *difficult*

Midterm #2 item analysis

"Worksheet like"

Question #s	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	B1-B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24
Averages:																																	
top 50%	87	97	83	57	97	57	73	97	95	78	83	86	97	97	63	83	80	97	93	90	87	77	78	93	85	77	49	78	33	45	63	93	62
bot 50%	52	90	45	31	93	28	52	97	83	70	66	67	83	83	38	69	62	66	45	76	45	38	67	83	66	61	26	59	7	22	53	86	41
discrim:	25	4	30	29	2	35	17	0	7	5	12	12	8	8	24	9	13	19	35	9	32	34	8	6	13	12	31	14	66	34	8	4	20

easy *good discriminator* *lecture only*

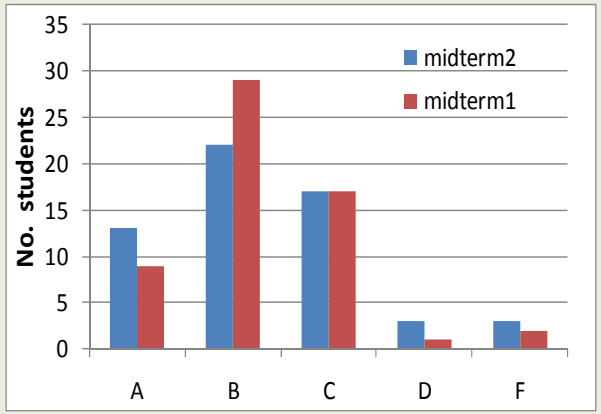
Colour key:

Green averages:

-Well done.

Green discrim:

- The question distinguishes top & bottom students



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

You decide ….

Opinion surveying

- Feedback from 59 / 64 students

(pin survey results here)