

# Driven to Distraction: Does the Infamous Earth Shadow Distractor Divert Student Attention in the Cause of the Phases of the Moon Question?

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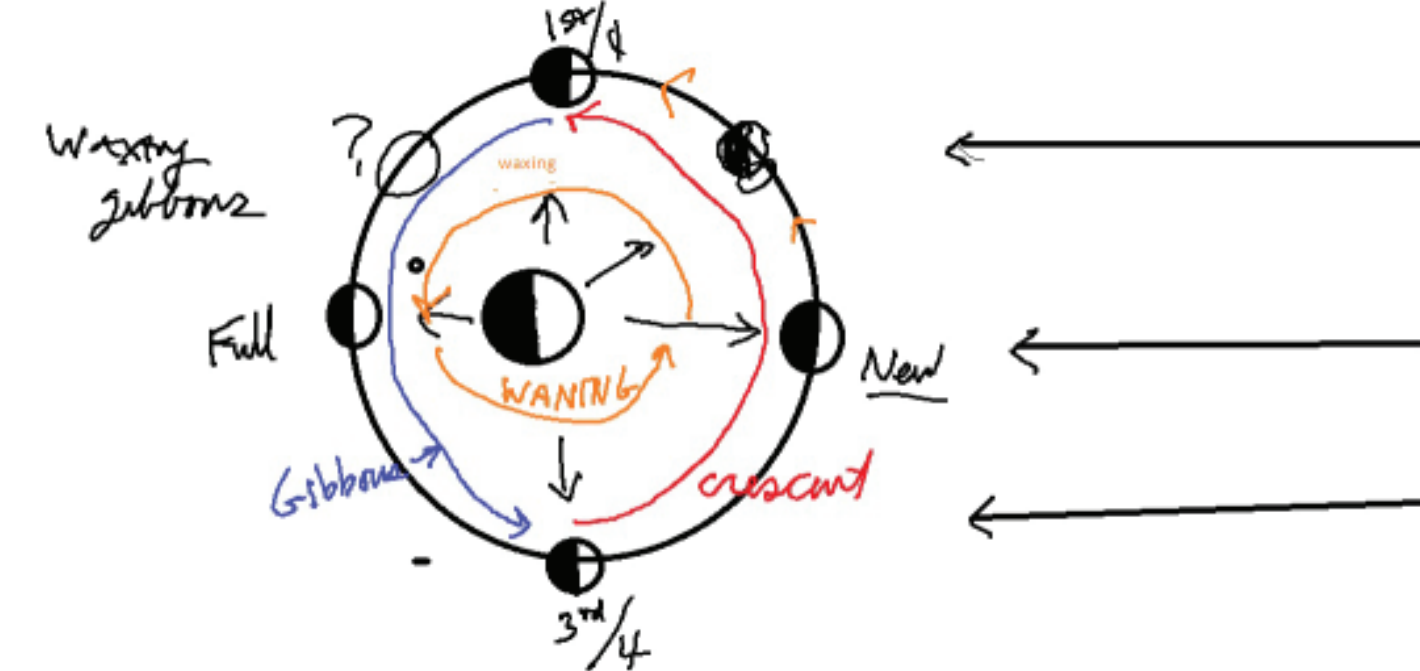


Scan for link to pdf of poster.

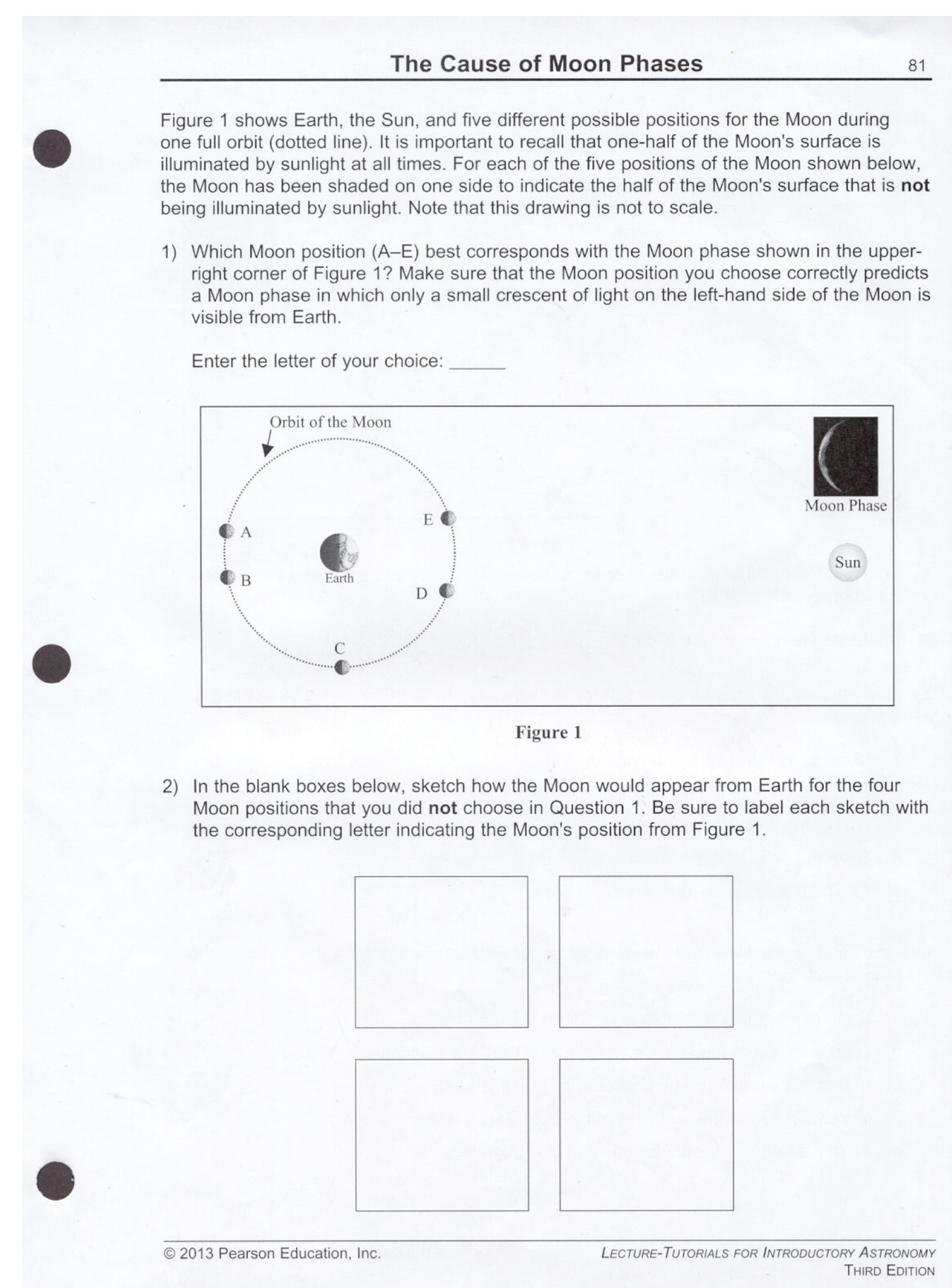
## Abstract

The concept of the cause of the phases of the Moon is one that is well known to be a problem for astronomy students, with a large fraction thinking incorrectly that the phases are caused by the shadow of the Earth. I have typically repeated this question from the first exam in the two-semester Introductory Astronomy course, through the final exam of the second semester, for a total of 8 appearances. It occurred to me that the inclusion of the shadow distractor in these multiple choice questions may actually reinforce the misconception by repeatedly distracting the student to the familiar but wrong answer. I am running an experiment to see if this is happening. I am giving different forms of the question to half the class for exams 2 and 3 of the first semester, exams 1-3 of the second, with half the class not getting the shadow distractor. I then am offering the shadow distractor to the whole class for the two semesters' final exams. The early results of this experiment will be discussed.

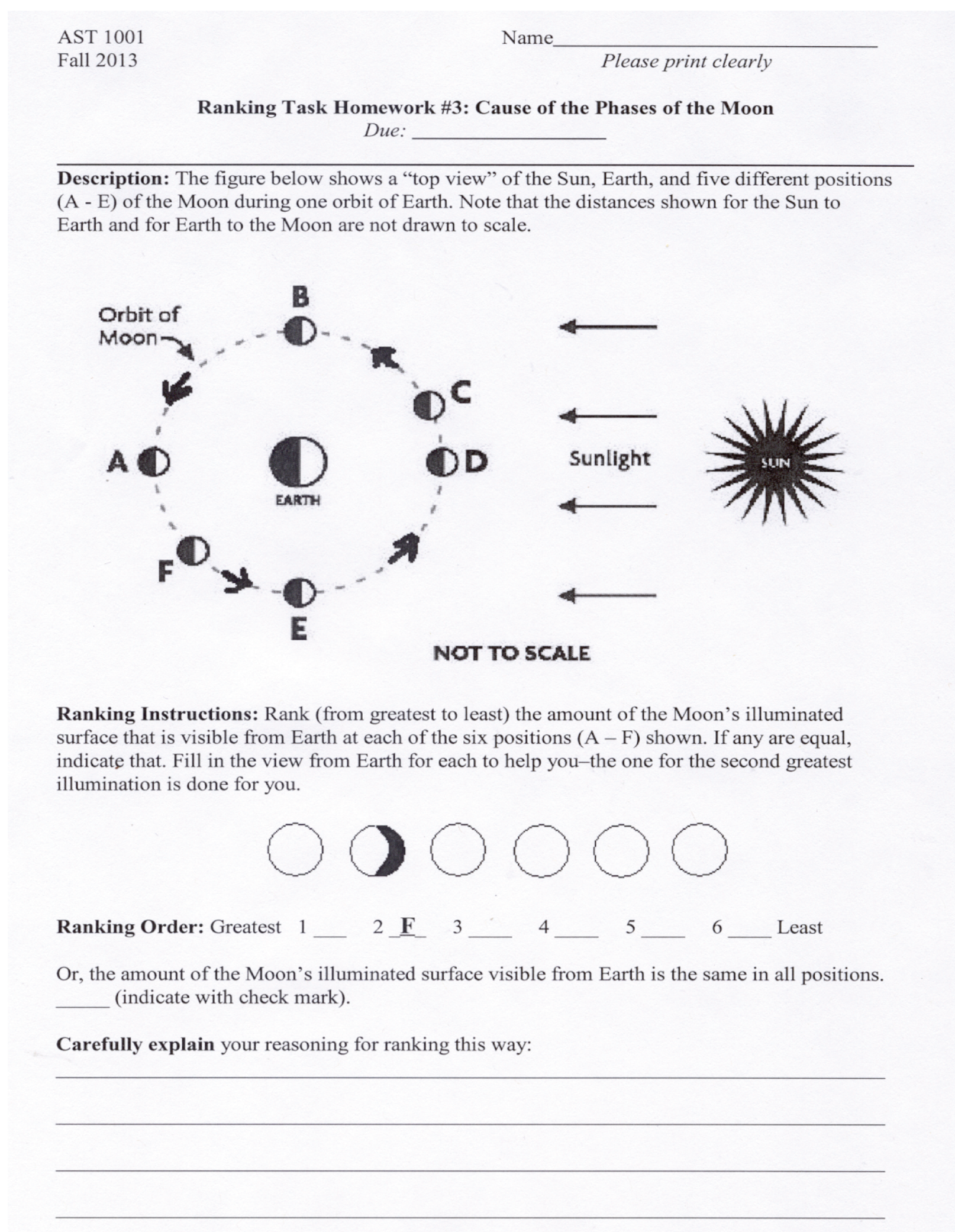
After the quiz about what they know, the answers are briefly discussed and then the cause is shown by sketching out the view of the Moon's orbit and the different phases, using Microsoft Paint, on the screen.



This is followed by the Lecture-Tutorial, Cause of the Moon's Phases (Prather et al., pp 81-83), which is done in class. The first page is shown below as a sample:



This completes a class meeting and the students are given a Ranking-Task Homework, edited from the unpublished Ranking Tasks available online to past participants of the CAE workshops. The first page is shown as a sample below. The class re-takes the concept-quiz PowerPoint question the next class.

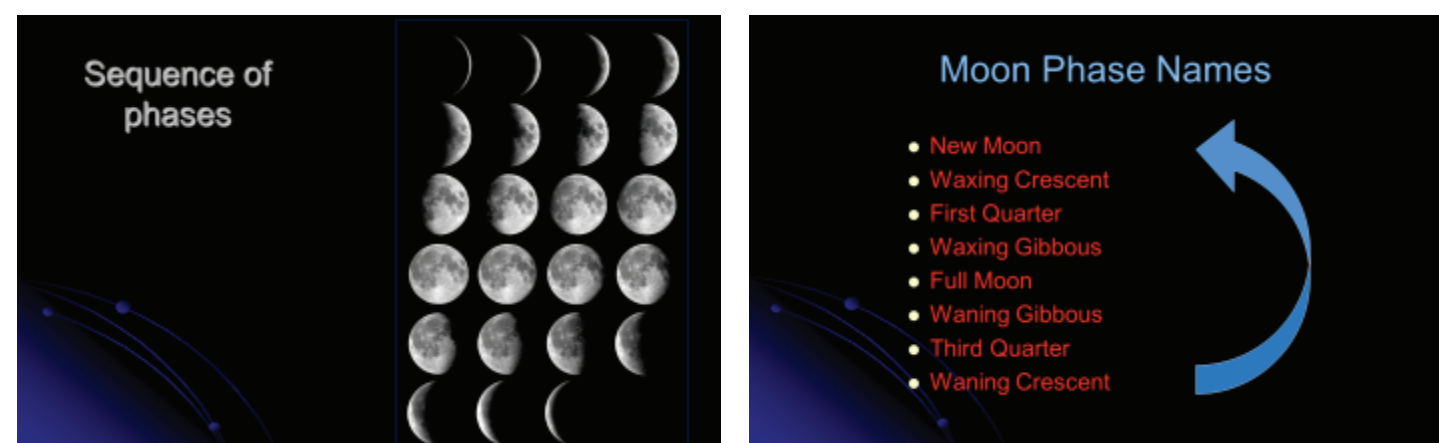


## General Teaching Technique

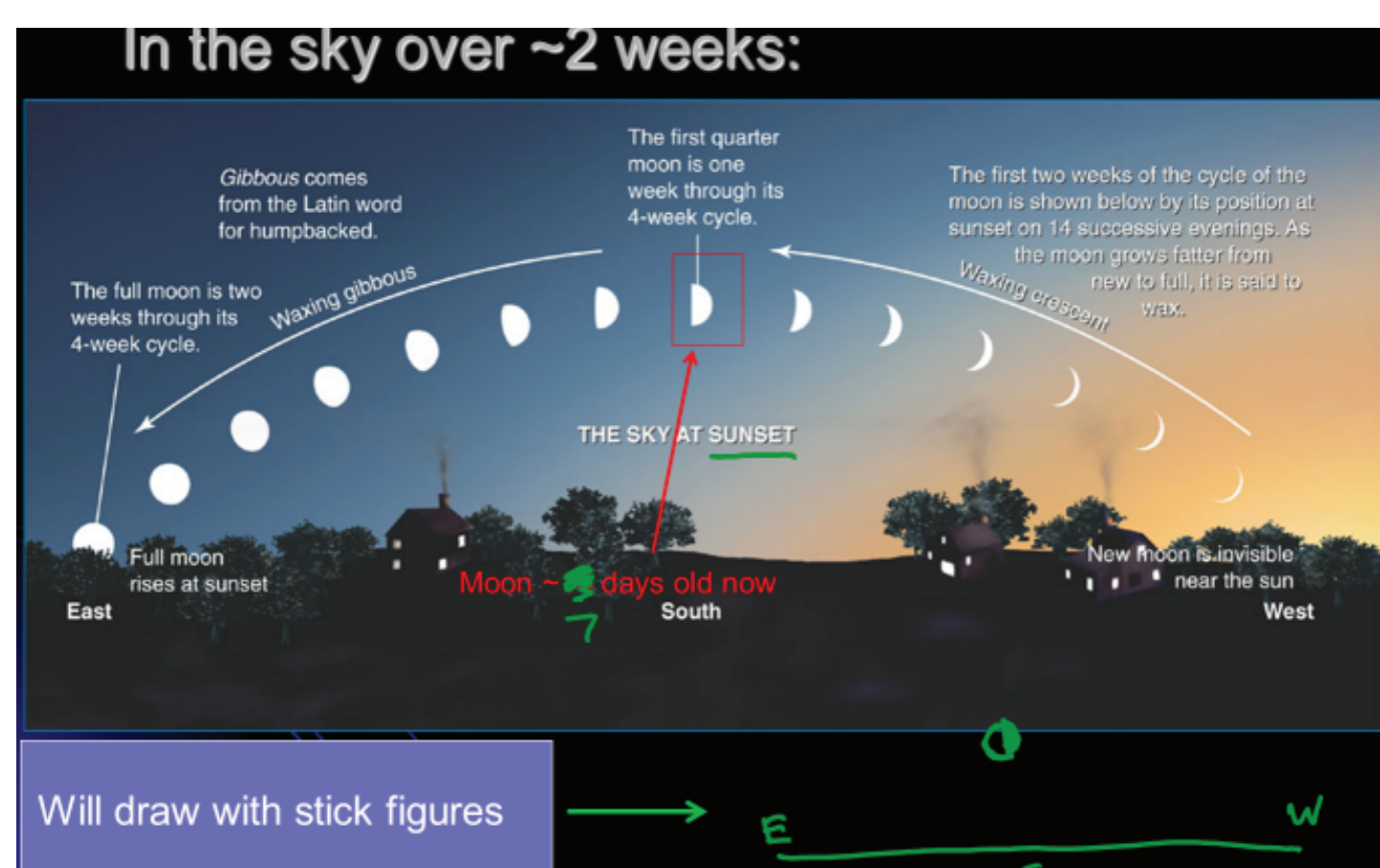
Well before the beginning of this experiment I started using the interactive astronomy teaching techniques developed at the Center for Astronomy Education (<http://astronomy101.jpl.nasa.gov/>), referred to hereafter as the CAE. The course is mostly a series of short (~15-20 minute) PowerPoint presentations, each followed by the students working in pairs on an activity in the Lecture-Tutorials for Introductory Astronomy (Prather et al., 2013). These take about 10-15 minutes and are followed by concept-quiz questions displayed on the screen that are answered in unison by the students, on command, holding up an ABCD color-coded card to their chests. This provides quick visual feedback. If the vast majority have it correct we go on, if not they are asked to discuss it for a minute with someone who disagreed with their answer, and trying to defend their answer to their disagreeing partner. A re-vote usually yields the vast majority now correct. If not, more time is spent on the subject.

## Instruction to the Phases of the Moon

The first PowerPoint on the phases of the moon is a simple graphical introduction that begins with a couple of slides introducing the visual appearance of the phases of the Moon and the phase name cycle (these are from the CAE):

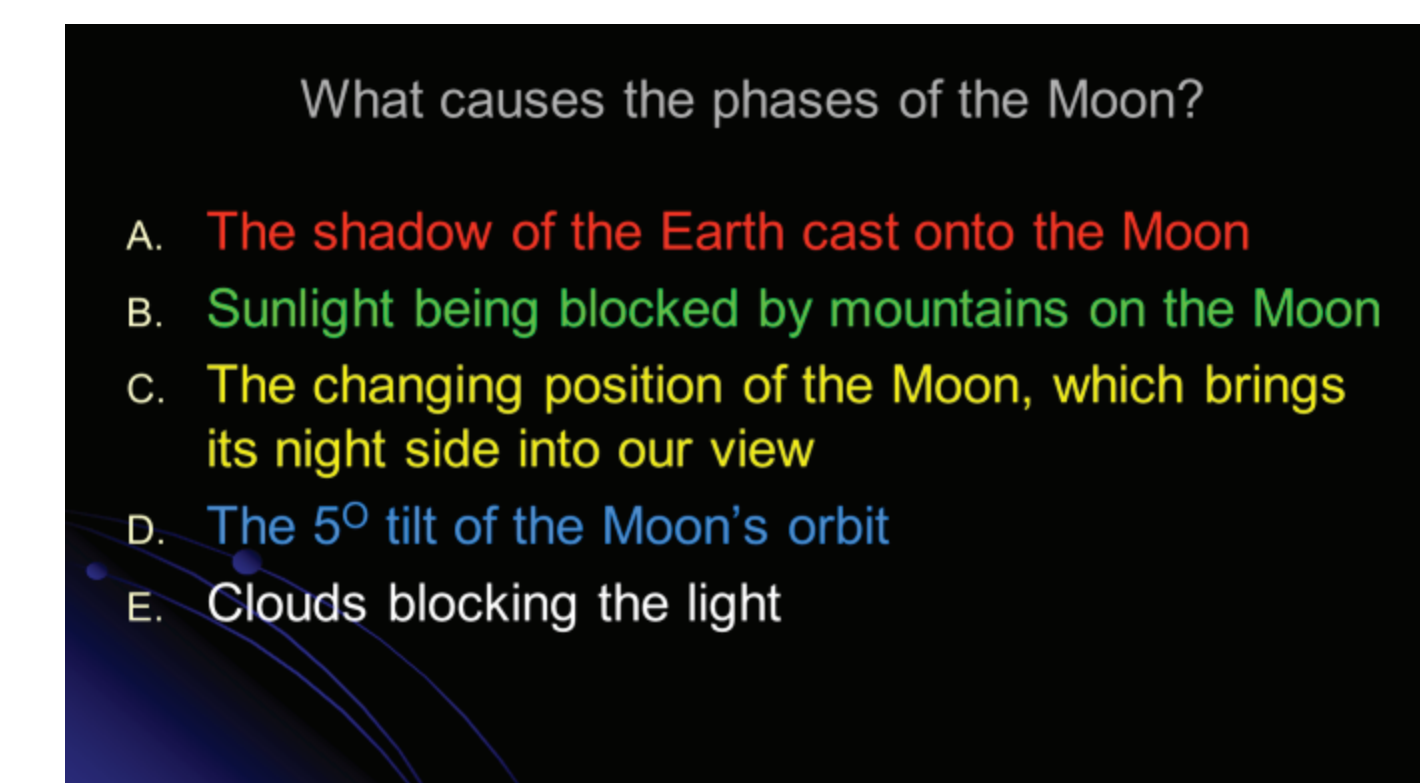


The position in the sky is shown for the new-to-full sequence at sunset is introduced with the following slide, which is based on a figure used in the textbook used in the course (Seeds and Backman 2014):



Note that this is marked up with the phase of the Moon on the day of lecture, if the moon is in this range, and that the simplification of this diagram to a stick figure is introduced in real time by marking up the slide (all PowerPoints are saved with markups and posted on AsULearn, our online, Moodle-based, teaching system.).

The students are then presented with a concept-quiz type question on what they already think the cause of the phases is:



## Testing the Concepts

The Introductory Astronomy course is a two-semester sequence, 4 credit hours (3 classroom hours and a 2-hour lab per week). In my section I give three exams and a comprehensive final each semester. The phases of the moon now appears first on Exam 1 of the first semester (in 2011 it appeared first on Exam 2). In addition, a pre-test is given the first week of class each semester and those questions are imbedded in the Final Exams to measure student learning. All exams are multiple choice, machine-scored. The question on the Moon's phases appears on all eight exams, including the first semester's pre-test.

Since 2011, the beginning of the experiment, after the first appearance of the phase question on an exam, the remaining regular exams are given with half the students receiving the **standard question**:

The Moon's phases (full, new, quarter, etc.), are caused by

- A) the shadow of the Earth cast onto the Moon
- B) the changing position of the Moon, which brings its night side into our view
- C) sunlight being blocked by mountains on the Moon
- D) the fact that one side of the Moon always faces us
- E) the five degree tilt of the Moon's orbital plane

The other half of the class gets the same question with the shadow distractor (A) replaced with a "cloud" distractor:

The Moon's phases (full, new, quarter, etc.), are caused by

- A) clouds blocking the light
- B) the changing position of the Moon, which brings its night side into our view
- C) sunlight being blocked by mountains on the Moon
- D) the fact that one side of the Moon always faces us
- E) the five degree tilt of the Moon's orbital plane

The Scantron sheets are divided into the two groups before machine-scoring although the same key is used since the correct answer in both cases is B. In the second semester these are further divided into students who had me for the first semester ("Mine" in tables to follow), and those who had another instructor ("Refugees" in tables to follow). Four faculty teach Introductory Astronomy and students may change instructors for the second semester. About half my students take my section for the second semester. There are 60 students in the class.

## Data

The experiment has run two complete academic years and is in the middle of the third year. The data resulting from the scoring is given here for each of the three years.

Exam	Percent of students who chose...				
	A	B (correct)	C	D	E
Pre-test	73	8	0	8	10
(Exam #1 did not yet do phases)					
Exam #2 (no shad/clds))	9	72	0	7	12
Exam #3 (shadow)	3	73	0	10	3
Exam #3 (clouds)	0	68	0	14	18
Final (shadow group)	4	89	0	7	0
Final (clouds group)	3	72	0	7	17
<b>Spring 2012</b>					
(pre-test has no phase quest.)					
Exam #1 (shadow), mine	3	72	0	1	1
Exam #1 (shadow), refugees	22	33	0	22	22
Exam #1 (clouds), mine	0	75	0	6	19
Exam #1 (clouds), refugees	0	46	0	36	18
Exam #2 (shadow), mine	6	75	0	12	6
Exam #2 (shadow), refugees	14	29	0	43	14
Exam #2 (clouds), mine	0	63	0	6	31
Exam #2 (clouds), refugees	0	33	0	56	11
Exam #3 (shadow), mine	12	76	0	6	6
Exam #3 (shadow), refugees	20	40	0	20	20
Exam #3 (clouds), mine	0	69	0	6	25
Exam #3 (clouds), refugees	0	46	0	36	18
Final (shadow group), mine	11	78	0	6	6
Final (shadow group), refugees	44	44	0	0	11
Final (clouds group), mine	0	64	0	36	0
Final (clouds group), refugees	0	75	0	12	12

Exam	Percent of students who chose...				
	A	B (correct)	C	D	E
Pre-test	57	28	0	5	10
Exam #1 (no shad/clds))	12	68	0	13	7
Exam #2 (shadow)	3	76	0	14	7
Exam #2 (clouds)	0	70	0	13	17
Exam #3 (shadow)	0	90	0	7	3
Exam #3 (clouds)	0	76	0	17	7
Final (shadow group)	0	83	0	14	3
Final (clouds group)	4	86	0	4	7
<b>Spring 2013</b>					
(pre-test has no phase quest.)					
Exam #1 (shadow), mine	0	85	0	8	8
Exam #1 (shadow), refugees	50	44	0	0	6
Exam #1 (clouds), mine	0	60	0	27	13
Exam #1 (clouds), refugees	0	33	0	40	27
Exam #2 (shadow), mine	8	85	0	8	0
Exam #2 (shadow), refugees	50	38	0	13	0
Exam #2 (clouds), mine	0	73	0	20	7
Exam #2 (clouds), refugees	0	40	0	27	33
Exam #3 (shadow), mine	0	92	0	0	8
Exam #3 (shadow), refugees	44	38	0	0	19
Exam #3 (clouds), mine	0	87	0	0	8
Exam #3 (clouds), refugees	0	57	0	21	21
Final (shadow group), mine	0	92	0	0	8
Final (shadow group), refugees	31	50	0	13	6
Final (clouds group), mine	13	67	0	20	0
Final (clouds group), refugees	29	64	0	7	0

Exam	Percent of students who chose...				
	A	B (correct)	C	D	E
Pre-test	54	27	0	7	13
Exam #1 (no shad/clds))	5	86	0	7	2
Exam #2 (shadow)	0	73	0	15	12
Exam #2 (clouds)	7	82	0	4	7
Exam #3 (shadow)	7	76	0	14	3
Exam #3 (clouds)	0	69	0	19	12
Final (shadow group)	0	86	0	14	0
Final (clouds group)	8	69	0	15	8

## Conclusions

While I have incomplete data at this point in the experiment, we can already note a couple of possible conclusions from the results, color-coded to the relevant data in the tables:

- With the exception of **Fall 2012**, the **group exposed to the shadow distractor** actually did better on the final exams than the **group with the clouds distractor substitution**. Perhaps repeated exposure to the wrong answer reminded them it was wrong. My hypothesis that the distractor would cause harm was wrong.

- The result was reversed for those students who did not have me for the first semester ("refugees"): the **subset of them exposed to the shadow distractor** tended to select it or even one of the other distractors, doing worse than the subset exposed to the clouds distractor.

- In general, the students ("mine"), exposed to the lunar phases concept via the interactive teaching method, did better than the "refugees," who were taught mostly with conventional methods.

## Future work

The experiment will continue through at least this academic year, and perhaps for another year or more for better statistics.

## References

Prather, E., Slater, T., Adams, J., and Brissenden, G. 2013, Lecture-Tutorials for Introductory Astronomy, 3rd edition. (San Francisco: Pearson Addison-Wesley)

Seeds, M. And Backman, D. 2014, Universe: Solar Systems, Stars and Galaxies, 8th edition. (Boston: Brooks/Cole)