

# “Flipping” a Course to Promote Engagement

Dr. Melissa N. Hayes-Gehrke  
Astronomy Dept., UMD

2016 GROWTH Education Workshop

# What is a “flipped” classroom?

The basic content information (facts, vocabulary, equations, and so on) are given prior to class in assigned readings, videos, or other resources.

Class time is used for activities and discussions that engage the student in actively thinking about and learning the material.

# How long have I been teaching flipped courses?

I flipped my introductory non-major astronomy course (ASTR 100) in summer 2010.

I thought it was very successful (even though I needed to improve my implementation), so I began flipping each of my other courses the next semester I taught them.

- ASTR 100: Introduction to Astronomy (non-major) x 10
- ASTR 220: Collisions in Space (non-major) x 5
- ASTR 300: Stars and Stellar Systems (non-major) x 1
- ASTR 310: Observational Astronomy (major) x 2
- ASTR 315: Astronomy in Practice (non-major) x 3

# Why did I flip my courses?

Education research has shown that active learning is more effective in enabling the students to learn. By eliminating lecture, I have more time to implement active learning activities.

# Why did I flip my courses?

- The style of a flipped classroom gives more flexibility to adapt a day's activities to focus on recent discoveries, emphasize material the students are struggling with, add topics they're interested in, and/or provide class time for work on course projects.
- The interaction between myself and students in a flipped classroom makes everyone more invested in the course.
- It is more interesting for me than repeatedly teaching the same lecture course.

# Why did I flip my courses?

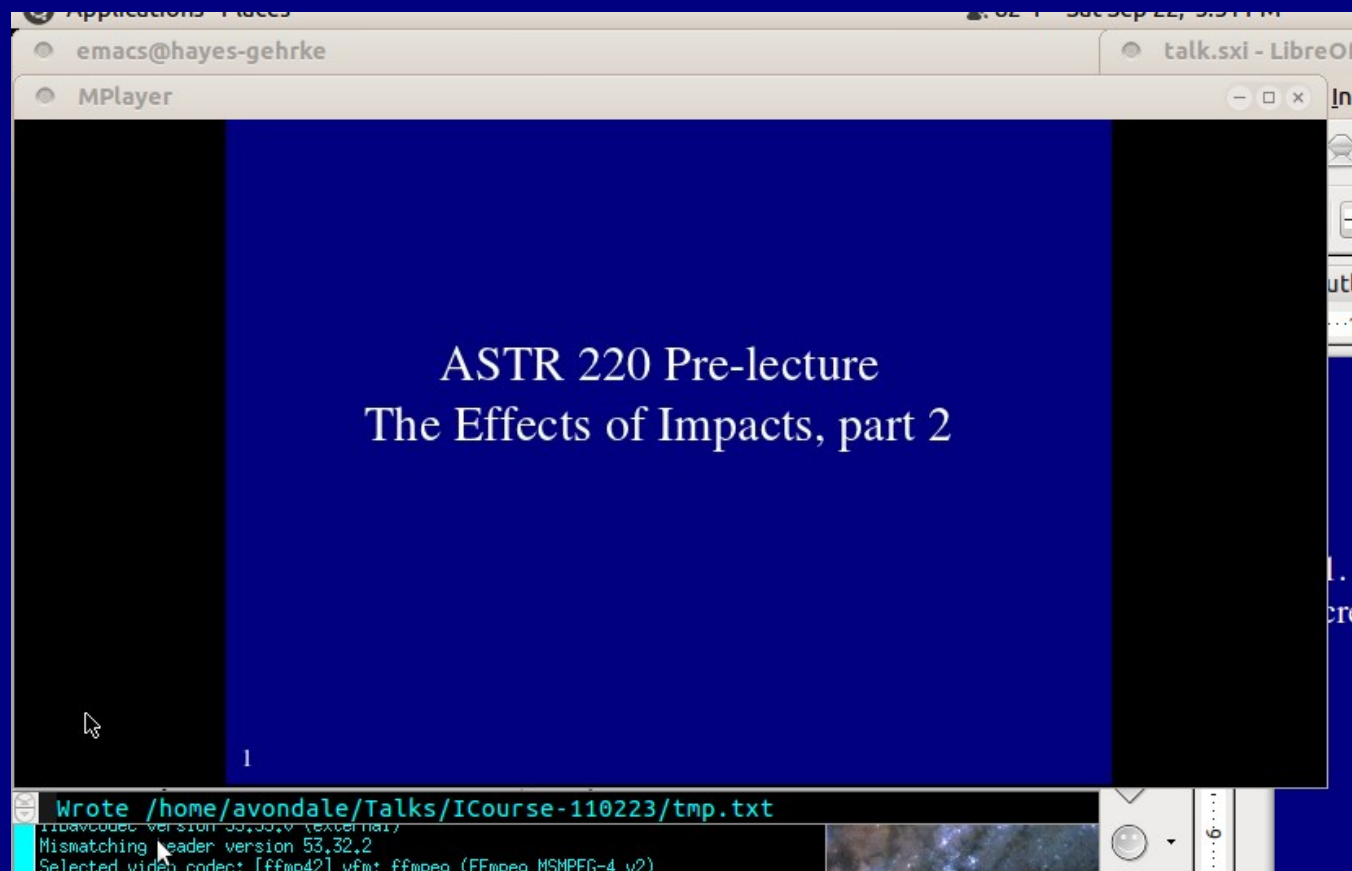
- Students zone out in lectures.
- Students do not read textbooks prior to class without strong incentive.
- No time in class to explore the ramifications of concepts and probe student understanding.
- Students *hate* homeworks.
  - Done at the last minute, so not done thoughtfully.
  - Don't understand the point of the problems and don't think about what their answers mean.
  - Cheating can be a significant issue.

# Course Procedure for My Flipped Courses

1. Pre-lecture material
2. Pre-lecture quiz
3. In-class activities (ungraded)
4. In-class writing activity for grade

# Course Procedure for My Flipped Courses

1. Prior to each class, students watch a pre-lecture video created by me or read assigned pages from textbook.





# Why do I do this?

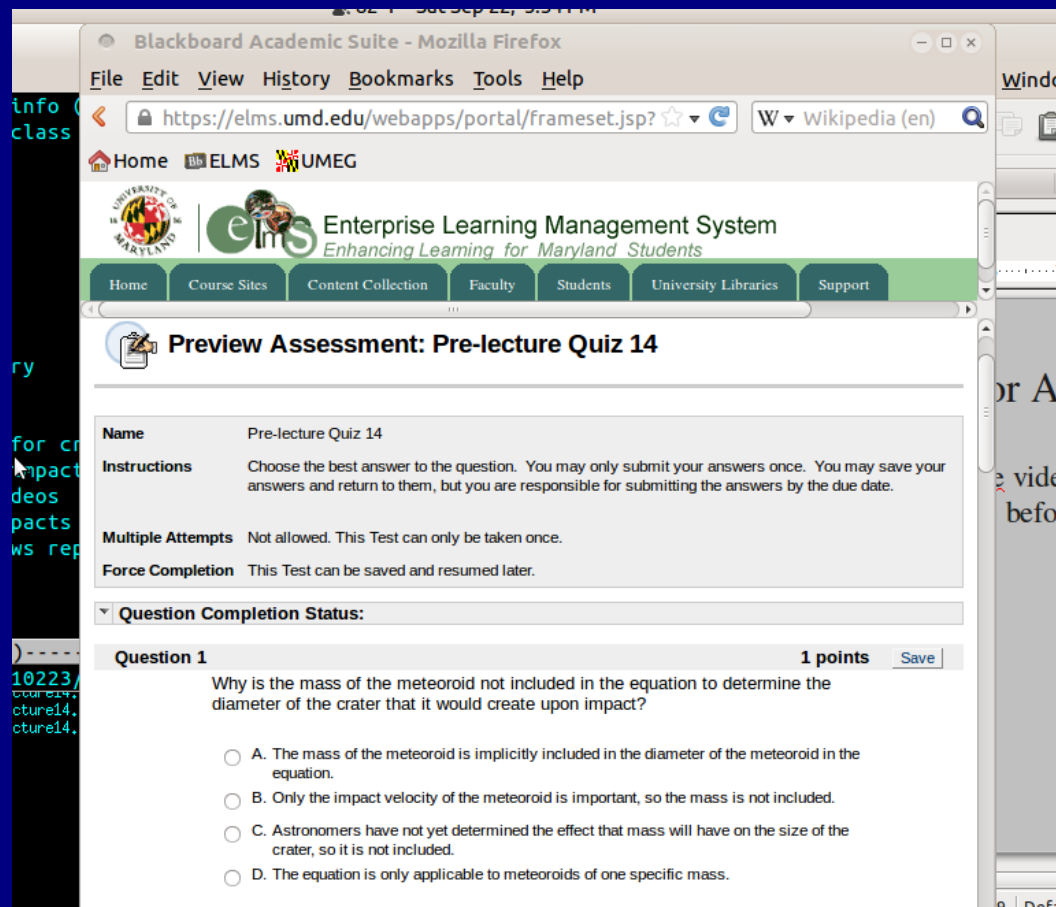
In the pre-lecture video or textbook reading, students learn basic facts, vocabulary, concept explanations, etc.

When students come to class, everyone should have the same background level of knowledge on the day's topics.

I resist the urge to assign a huge amount of material in the pre-lecture – they don't really have “unlimited” time, because they are taking other courses, too!

# Course Procedure for My Flipped Courses

2. After watching the pre-lecture video or doing the reading, students complete a quiz on the LMS before class.



The screenshot shows a web browser window displaying the Blackboard Academic Suite interface. The browser's address bar shows the URL <https://elms.umd.edu/webapps/portal/frameset.jsp?>. The page title is "Blackboard Academic Suite - Mozilla Firefox". The browser's menu bar includes "File", "Edit", "View", "History", "Bookmarks", "Tools", and "Help". The page content includes the University of Maryland logo and the "Enterprise Learning Management System" header with the tagline "Enhancing Learning for Maryland Students". A navigation menu contains links for "Home", "Course Sites", "Content Collection", "Faculty", "Students", "University Libraries", and "Support". The main content area is titled "Preview Assessment: Pre-lecture Quiz 14". Below the title, the quiz details are listed: Name: Pre-lecture Quiz 14; Instructions: Choose the best answer to the question. You may only submit your answers once. You may save your answers and return to them, but you are responsible for submitting the answers by the due date.; Multiple Attempts: Not allowed. This Test can only be taken once.; Force Completion: This Test can be saved and resumed later.; Question Completion Status: A dropdown menu. The first question is displayed: "Question 1" (1 points) with a "Save" button. The question text is: "Why is the mass of the meteoroid not included in the equation to determine the diameter of the crater that it would create upon impact?". The question has four multiple-choice options: A. The mass of the meteoroid is implicitly included in the diameter of the meteoroid in the equation.; B. Only the impact velocity of the meteoroid is important, so the mass is not included.; C. Astronomers have not yet determined the effect that mass will have on the size of the crater, so it is not included.; D. The equation is only applicable to meteoroids of one specific mass.

# Why do I do this?

Students, especially nonmajors, need encouragement to watch the pre-lecture video or do the reading.

If they go over the material, the quizzes are not difficult (averages 90%+), but most students can't get good scores by guessing.

The quizzes also provide me with feedback about which students are falling behind by skipping assignments. For students, daily accountability provides them with frequent exposure to the material.

# Course Procedure for My Flipped Courses

## 3. During class, students:

- answer think-pair-share questions
- discuss open-ended questions
- do calculations to practice using the equations
- other active learning activities appropriate for topic
- attendance is taken as “class participation” (non-majors)

# Course Procedure for My Flipped Courses

While the students are discussing questions or doing activities, I circulate around the classroom.

- I'm nosy – I jump in and ask students what they think about the question and what their reasoning is.
- I eavesdrop – I try to hear how students are explaining the concepts to their peers and what problems they are having.

I sometimes “debrief” activities afterward – why did I have them do it? Why is the concept important?

# Why do I do this?

Removing myself from the front of the room makes me less intimidating and more approachable to the students.

I make connections with individual students and convey my sincerity in helping them learn.

I discover problem areas or misunderstandings that I hadn't realized existed.

If students are getting off-topic, I can re-direct them.

# Course Procedure for My Flipped Courses

4. At the end of class, students write a 1-paragraph answer to a conceptual question based on the day's topic.

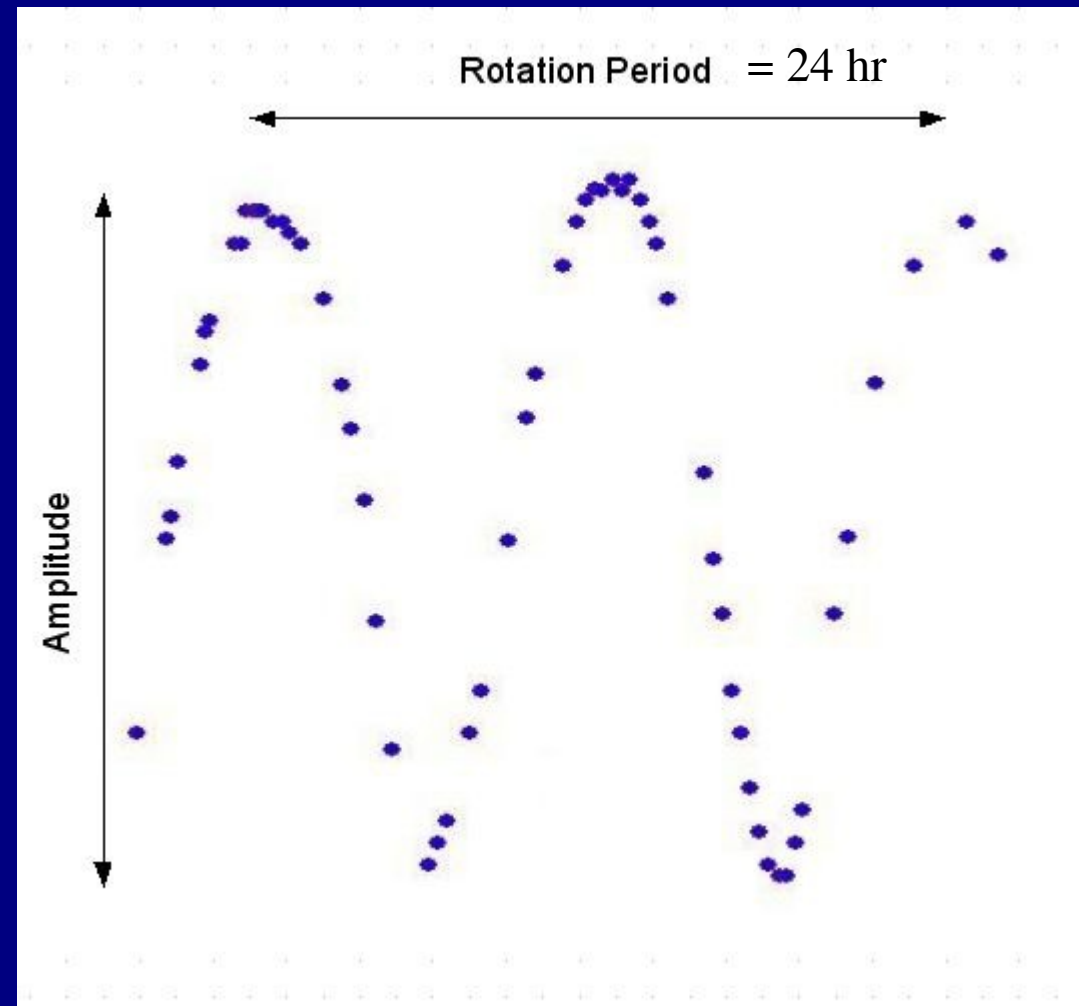
After writing a rough draft, each student exchanges with another student. They read and critique each other's answers.

They get their papers back, discuss the critiques, and re-write answers taking into account the critique.

# *Example from ASTR 315: Astronomy in Practice*

Imagine that we observe the asteroid below, which has a rotation period of 24 h (but when we observe it, we don't know that).

Suppose that we observe the asteroid from 6pm – midnight for 3 consecutive nights. Sketch what the unphased lightcurve would look like. **Explain your reasoning for your sketch.**





# Why do I do this?

The problem is related to the day's concepts but at a more challenging level.

Students must think through and apply the concept(s), thereby reinforcing their understanding.

The exchange-and-critique exposes each student to another student's reasoning, which forces them to think through the concept(s) again. Critiquing and explaining their critique gives the students another chance to articulate their thinking.

Exchange-and-critique also makes the final answers better, expediting grading.

# Example of One “Lecture” in a Flipped Course

*ASTR 220: Collisions in Space – the Threat of Asteroid Impacts*

Non-major course with no science or math pre-requisites.

Focuses on how astronomers study asteroids, what effects an impact might have, and what we can do to prevent an impact.

# The Effects of Impacts, part 2

## *Pre-lecture Information*

The diameter of the impact crater is related to the diameter of the meteoroid and the impact velocity.

$$D = 1.16L \left( \frac{v^2}{gL} \right)^{0.22}$$

**D:** diameter of crater created

**v:** velocity of asteroid at impact

**g:** gravitational acceleration of Earth, approx.  $10 \text{ m/s}^2$ .

**L:** diameter of asteroid, assuming it is average

# Example: Effects of Impacts, part 2

## *Pre-lecture Information*

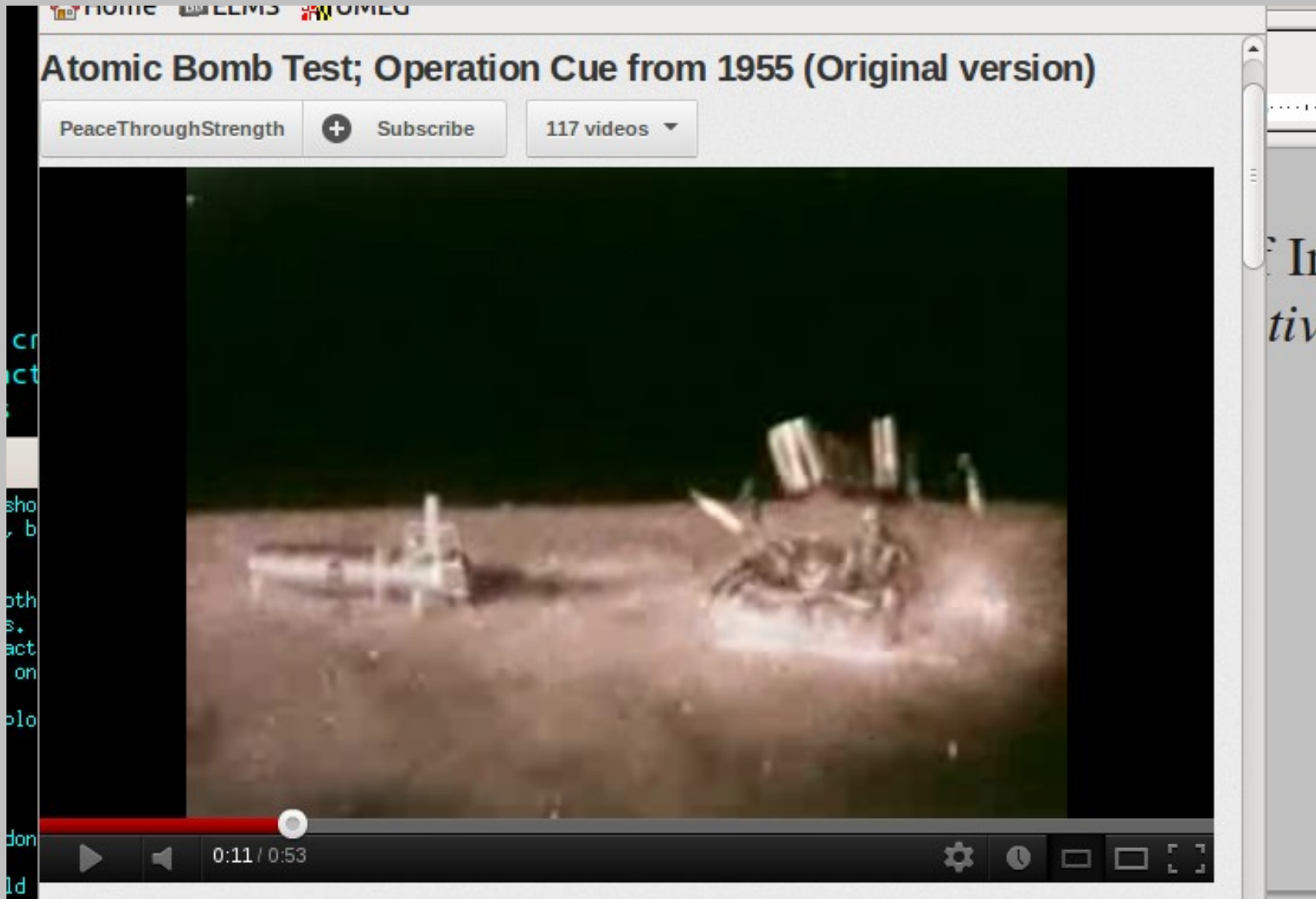
The destruction from heat extends much farther than the impact crater.

<b>Meteoroid Diameter</b>	<b>Crater Diameter</b>	<b>Plywood Ignites</b>	<b>3<sup>rd</sup> Degree Burns</b>	<b>Newspaper Ignites</b>
50 m	0.9 km	2.5 km	3.2 km	3.6 km
100 m	1.6 km	6.1 km	7.7 km	8.6 km
300 m	3.7 km	23 km	29 km	33 km
1000 m	9.5 km	110 km	130 km	150 km

These examples assume the meteoroid has an average density of 2 kg/L and impact velocity of 12 km/s.

# Example: Effects of Impacts, part 2

## *In-class Activities*



# Example: Effects of Impacts, part 2

## *In-class Activities*

- Each team will receive a population density map for a specific state.
- Each team will imagine an impactor of a certain size and impact velocity has hit the location specified in their state.
- Determine the following:
  1. The size of the impact crater.
  2. The number of people killed by the impact and shockwave.
  3. The number of surviving people with 3<sup>rd</sup> degree burns.

# Example: Effects of Impacts, part 2

## *In-class Activities*

All impact velocities are  $1.2 \times 10^4$  m/s.

TEAM	IMPACT LOCATION	IMPACTOR SIZE
<u>Euphrosyne</u>	Fresno Co., CA	80 m
Pomona	<u>Twiggs Co., GA</u>	80 m
Polyhymnia	<u>Anne Arundel Co., MD</u>	80 m
Circe	<u>Moniteau Co., MO</u>	80 m
<u>Atalante</u>	Fresno Co., CA	160 m
Leda	<u>Twiggs Co., GA</u>	160 m
Laetitia	<u>Anne Arundel Co., MD</u>	160 m
Harmonia	<u>Moniteau Co., MO</u>	160 m
Daphne	Sheridan Co., ND	160 m
Isis	Fresno Co., CA	240 m
Ariadne	<u>Twiggs Co., GA</u>	240 m
<u>Nysa</u>	<u>Anne Arundel Co., MD</u>	240 m
Eugenia	<u>Moniteau Co., MO</u>	240 m
gHestia	Sheridan Co., ND	240 m

# Example Grading Scheme for a Flipped Course

For *ASTR 315: Astronomy in Practice* (non-major)

Type of Assignment	% of Course Grade
class participation	5%
pre-lecture quizzes	15%
in-class writing activity	10%
daytime labs	10%
course project	35%
midterms (2)	15%
final exam	10%

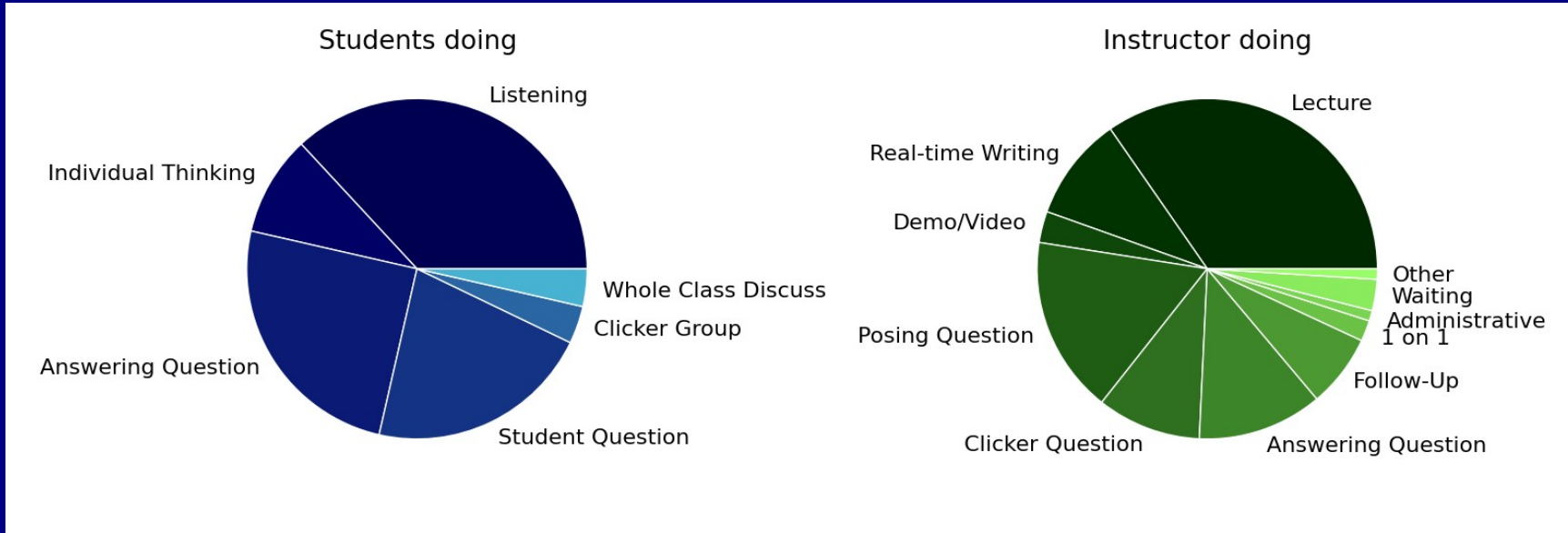


# More Motivation to “Flip” Courses

- Education research is starting to show that the traditional lecture method of teaching preferentially benefits economically advantaged white males, and is not as effective for women, minorities, or low-income and first-generation college students.
- Students themselves are hearing/experiencing that there are more effective teaching methods than lectures and are beginning to expect something different.

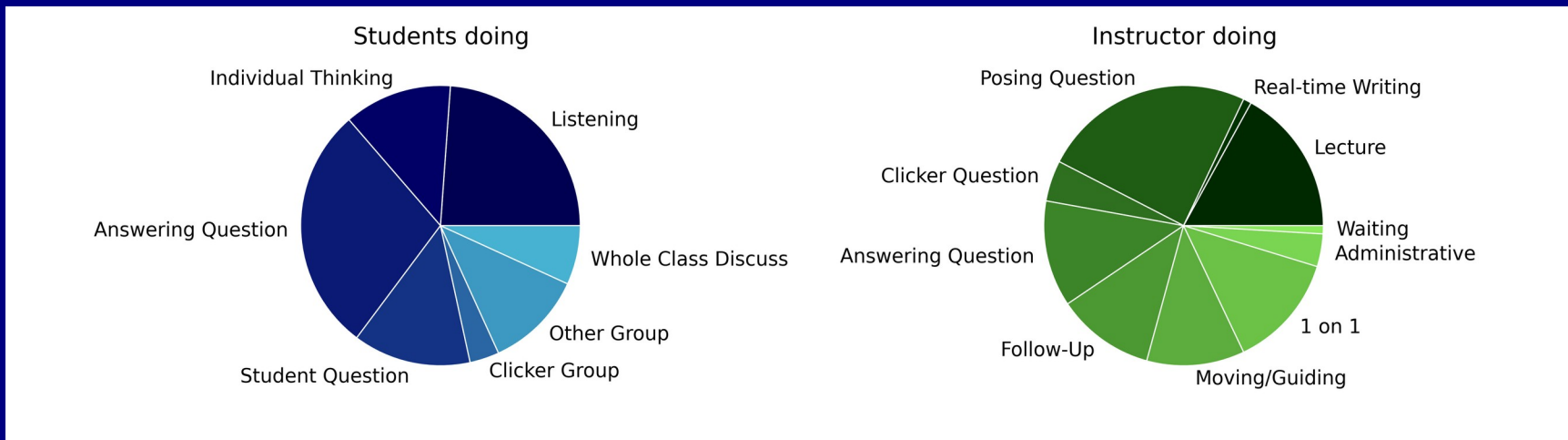
# Classroom Observation Protocol for Undergraduate STEM observations of classrooms with lecture vs. flipped:

lecture



DCR ASTR 121 observed by AO 5/2/15

flipped



MNH ASTR 220 observed by AO 11/3/15

# More Motivation to “Flip” Courses

- Interesting reading – Google the titles and authors:
  - “Professors Shouldn't Teaching to Younger Versions of Themselves” by Rebecca Schuman, formerly faculty at U Missouri-St. Louis and OSU, now at Slate.com
  - “Are College Lectures Unfair?” by Annie Murphy Paul in *New York Times*
  - “A Lecture from the Lectured” by a group of students at University of Illinois at Urbana-Champaign.

# Anonymous Student Comments on Course Evaluations

“The professor's method to have pre-lectures teach material with the lecture usually being interactive discussion is very effective and kept me engaged in the class all semester long.”

“...the class was interesting, and the instructor had one of the best methods of teaching this material that I've ever experienced. It was very hands-on...the passive parts were done at home, to get them out of the way, and the active parts were done in class, instead of the other way around. I loved this course.”

# Anonymous Student Comments on Course Evaluations

“I really liked the teaching style. Having to watch the prelecture videos before each class,[sic] helped me to better (fully) understand the material faster compared to more traditional lectures.”

# Preparing Your Students for a Flipped Course

Although flipped courses are becoming more common, it's only fair to tell your students these things on the first day of class:

- What your course procedure will be
- WHY you are teaching your course this way
- How each student's course grade will be determined

# Caution!

Resist the urge to start lecturing during the class time.

The students should be doing a lot, maybe most of the speaking.

If you try to “double up” with a pre-lecture and an in-class lecture, the students will quickly become resentful.

Conversely, if you assign them an activity and disappear for a coffee break, they will resent that, too.