

# C10 Lesson Plans and Reflections (Fall 2020)

Jacob Pilawa

Ay375/Astronomy C10

## 1 Week 1 Lesson Plan

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### 1.1 Links

**Slides:** [https://docs.google.com/presentation/u/2/d/1lgrzu2Wdsm46U1bTTCLQNUG5ff0hqodgTCnIScvk70w/edit?usp=drive\\_web&oid=112685696978276597869](https://docs.google.com/presentation/u/2/d/1lgrzu2Wdsm46U1bTTCLQNUG5ff0hqodgTCnIScvk70w/edit?usp=drive_web&oid=112685696978276597869)

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### 1.2 Lesson

- **Chit Chat (Popcorn Style):** ~10 Minutes of Berkeley Time
  - Where are people calling in from/what year they are?
  - Most interesting thing within an arm's reach?
  - Most interesting thing you've done in the last 24 hours.
  - Also have people fill this out: <https://forms.gle/LJ1wap1CzSGjbX5w8>
- **APOD:** ~5 Minutes
  - What you're looking at is a large cloud of hydrogen gas around a bunch of stars you can see in the night sky. Point out Deneb. This is in the constellation of Cygnus the Swan which is more or less overhead this time of years. The who cloud is around 1400 light years away.
- **Introduction:** ~5 Minutes
  - Where I'm from?
  - What I'm doing for graduate school?
  - Where I came from for undergrad?
  - What do I like outside of school?

- **Syllabus:** ~10 minutes
    - Screen share the syllabus.
    - Talk it through, not in gory detail. Talk about expectations and leave plenty of room for questions.
  - **Website:** ~5 minutes
    - Screen share to show how to get there.
    - Got feedback from yesterdays class to do this. Let me know if you think this is useful:
    - <https://bcourses.berkeley.edu/courses/1497177/pages/discussion-sections-102-111-122-132>
  - **Horoscope Icebreaker:** ~10 minutes
    - Make a Google Document with the horoscopes from the day before. Also make sure to write all the dates for the various signs.
    - <https://docs.google.com/document/d/11HS8-atIiNqc0wtJjqx7gPUks-1LBdREwcQ6HET-FKc/edit?usp=sharing>
  - **Marshmallow Icebreaker:** ~20 minutes
    - Estimate number of marshmallows stacked to the sun.
    - Need to say why this is important/relevant.
    - Send to breakout rooms to have them come up with an answer and **state assumptions**. (10 minutes)
    - Come back, share, talk about work and how this might be relevant to astronomy (10 minutes).
    - <https://docs.google.com/document/d/1Snq34An5eqJi3WAaV9MYt2sLJ9DsVaJ4vMo0iBUEmxQ/edit?usp=sharing>
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### 1.3 Reflection:

**Atmosphere and Learning Objectives:** I want to curate a fun, supportive, and engaging atmosphere the first day. I don't think that it's important to jump right into material, but rather give the students the chance to talk to me and feel out my expectations. I also hope to take some time to have them talk to each other and start a semblance of an online community. I hope that they learn a bit about me and my excitement for astronomy. Additionally, I hope they learn that I am here as a resource for them.

**Assessment of Objectives:** I think it will be difficult to assess whether or not the first week is successful. I think I will get a feel from the vibe of the Zoom call. If I come away with someone emailing me a question in a week or so, I will feel happy.

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## 2 Week 2 Lesson Plan

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### 2.1 Links

**Slides:** <https://docs.google.com/presentation/d/1N1MW0U9bXFn8G81XcyK0o1msgj3B3Q6riaBfjvfE2bM>

**Breakout Rooms:** [https://docs.google.com/presentation/d/1yRzTTAPqwztJx4pq-k5qev8XIRWkDFvZa-x3Ev-W\\_Ic/edit?usp=sharing](https://docs.google.com/presentation/d/1yRzTTAPqwztJx4pq-k5qev8XIRWkDFvZa-x3Ev-W_Ic/edit?usp=sharing)

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

**Learning objective:** I want the students to come out of this understanding that the spectra of stars and emission spectra of nebulae show us the composition of the object. The stretch goal would be to have them see the Balmer series and recognize that as hydrogen, as well as provide justification at the atomic scale why this happens.

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### 2.2 Lesson

- **Chit Chat (Popcorn Style):** ~10 Minutes of Berkeley Time
  - Get slides set up. Ask about most interesting thing people have done in the last week.
- **APOD:** ~5 Minutes
  - System of galaxies called Arp 227. The left galaxy is called NGC 470, the right galaxy is NGC 474. NGC 470 is close to how our own galaxy would look.
  - They're 100 million ly away in the constellation of Pisces! Which is visible! I think it's around 12:30AM here NW sky. That's at least where Aquarius is.
  - What do you notice about the galaxies (try to get them to say shape).
  - Why might it be? It's because they merged and are passing through each other! And the Milky Way will do that too with the Andromeda galaxy.
- **Questions from Last Time:** ~5 Minutes
  - Go through slides with feedback from last time.
- **Light Review and Activity:** ~15 Minutes
  - Show slides of EM spectrum. Describe differences across the spectrum (freq., wavelength, energy). Make note of the taxonomy of the EM spectrum.
  - Send them to breakout rooms! Here is a link to the activity [https://docs.google.com/presentation/d/1yRzTTAPqwztJx4pq-k5qev8XIRWkDFvZa-x3Ev-W\\_Ic/edit](https://docs.google.com/presentation/d/1yRzTTAPqwztJx4pq-k5qev8XIRWkDFvZa-x3Ev-W_Ic/edit). The activity asks them to label the EM spectrum and describe it, as well as think of something that might emit that radiation.

- **Atoms and Atomic Spectra Demo:** ~15 Minutes
    - Review Bohr model of atom and explain how each element has a unique finger print embedded in how the electrons are “arranged.” Then show the ClassAction demos on spectra. It’s in Applications and on Desktop.
  - **End:** ~5 Minutes
    - Send out weekly survey: <https://forms.gle/hPRnNc8mpzRifzq97>
    - Open it up to questions.
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## 2.3 Reflection

## 3 Week 3 Lesson Plan

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### 3.1 Links

**Slides:** <https://docs.google.com/presentation/d/1vb0LD-W9qMcxqVj87naZWPRyA9a9LaMX9UvxN-4NoHw/edit>

**Break Out Rooms:** <https://docs.google.com/presentation/d/1vuPxoFkZEAHNouN6rB3S90wD2X2v7XzWlDz4pfRLkwy/edit?usp=sharing>

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

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### 3.2 Learning Objective

I really want to drive home familiarity with spectra today. I put a lot of time into an activity using a real spectrum of the star Vega, so I hope that goes well. I want them to come out of that activity understanding what a spectrum is and how to read one from a plot.

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### 3.3 Lesson

- **Berkeley Time:** ~ 10 minutes
- **APOD (Hercules Cluster M13):** ~ 10 minutes
  - One of the brightest “globular” clusters in the night sky. Why is it called globular? Compare it to an open cluster.
  - It is in our own Milky Way galaxy, about 25,000 light years away.
  - Visible easily with a telescope, almost visible with the naked eye in great conditions.
  - **Arecibo message:** In 1974, we sent a radio signal to the cluster which contained encoded information about the human race, DNA, atomic numbers, Earth’s position and other information, was beamed from the Arecibo Observatory radio telescope towards M13 as an experiment in contacting potential extraterrestrial civilizations in the cluster.
- **Arc Lamp Demo:** ~ 10 minutes
  - Show the demo of the spectral lamp. Discuss it. I am personally more excited about the next activity, so don’t beat this to death.
- **Spectra and Measurements of Stars with Breakout Rooms:** ~ 20 minutes
  - Use the breakout room link above and the slides. The major topics I am covering are spectra and black bodies. Then I have an activity where I take Vega’s spectrum and have them calculate it’s temperature, the energy of  $H\alpha$  photons, and then identify it on the spectrum.

- **Course Content Questions:** ~ 10 minutes
    - Open it up to questions. Give 10 minutes this week instead of 5. Lots of questions last time, and people had asked for it in survey.
  - **Weekly Survey:** ~ 5 minutes
    - Link: <https://forms.gle/hPRnNc8mpzRifzq97>
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### 3.4 Reflection

One of the most immediate thoughts I have following this lecture is that I appreciated the feedback someone gave me the week before to have more time at the end of the section for questions on lecture content. A surprising number of students had questions really specific to topics from lecture, and I am glad I allotted 10 minutes for that instead of the usual 5 since that time was all full for questions.

I also think the activity we did was particularly helpful. The feedback on the Google Form was extremely positive, with the main downsides being not enough time. That will always be trouble. Other than that, things went smoothly.

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## 4 Week 4 Lesson Plan

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### 4.1 Links

**Slides:** [https://docs.google.com/presentation/d/1ofMlKGdVfuX0o1-UxgoSZPcUzYXTRsTBfZyVUpJS5iE/edit#slide=id.g98759045df\\_0\\_209](https://docs.google.com/presentation/d/1ofMlKGdVfuX0o1-UxgoSZPcUzYXTRsTBfZyVUpJS5iE/edit#slide=id.g98759045df_0_209)

**Break Out Rooms:** [https://drive.google.com/drive/u/0/folders/194Y\\_UYNrI7vSN80HAhK035RWeI2U\\_Az9](https://drive.google.com/drive/u/0/folders/194Y_UYNrI7vSN80HAhK035RWeI2U_Az9)

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

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### 4.2 Learning Objective

The purpose of this week is to prepare for the quiz (next week). I am preparing them pretty explicitly for the material on the quiz because I think it's on the more difficult side. I want to have them do most of the discussion, but come back periodically to check understanding of the course content.

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### 4.3 Lesson

- **Berkeley Time:** 10 minutes
- **APOD: NGC 2442** ~ 10 minutes
  - This is all written out on the slides. There's a lot of really great content here to prepare for the quiz. These slides are also extremely pretty!
- **Broad Questions:** ~ 5 minutes
  - This should be quick – I just want to leave it open to questions before we do review.
- **Break Out Rooms** ~ 10 minutes per question
  - Send them to breakout rooms and have them work together. Bring them back and discuss.
  - Q1: <https://docs.google.com/presentation/d/1QSFHJLBmALFGe7F9krv2SRVB-G00iTVv150eufK4X9E/edit?usp=sharing>
  - Q2: <https://docs.google.com/presentation/d/1LzR0WXNpS1e0EulcJoZuWvHiKUSikcmCdI7L7rMBGwY/edit?usp=sharing>
  - Q3: [https://docs.google.com/presentation/d/1ZrxJ9Zu\\_pR2-cLD3Mm5VcdNWNip6V4xwOd8nXmsbViA/edit?usp=sharing](https://docs.google.com/presentation/d/1ZrxJ9Zu_pR2-cLD3Mm5VcdNWNip6V4xwOd8nXmsbViA/edit?usp=sharing)

- **Google Form:** <https://forms.gle/hPRnNc8mpzRifzq97>
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#### 4.4 Reflection

This could have gone better, I think. It went fine, but I was reading the feedback from the Google Form and this style of quiz preparation seems to be hard. I think next time, I might have a question on the screen, give people time to work on it (while playing music perhaps), and then explicitly work through it together on the board.

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## 5 Week 5 Lesson Plan: Quiz!

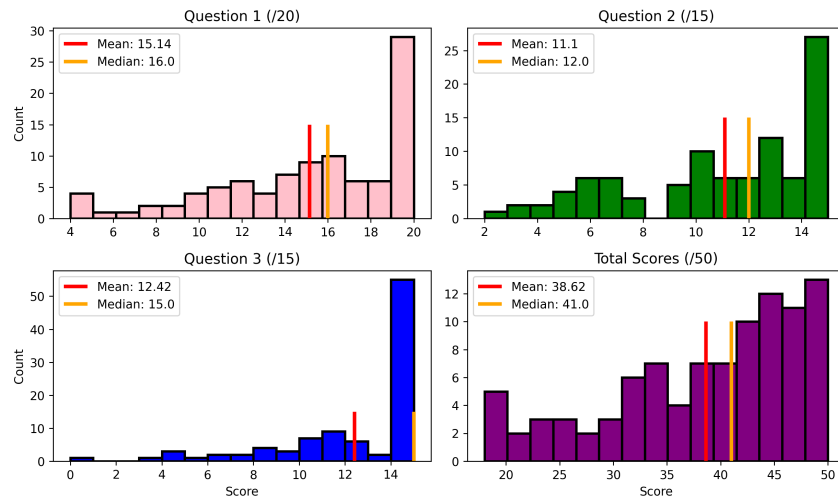


Figure 1: Scores from the quiz.

## 6 Week 6 Lesson Plan

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### 6.1 Links

**Slides:** <https://docs.google.com/presentation/d/1MJYjCEC8zx00GKM5vJwXV0nEChw6u9iYETo7FQTaWG4/edit#slide=id.p>

**Break Out Rooms:** [https://docs.google.com/presentation/d/17Eb57Ldgw35Q75\\_9dJlM7pHoDM9IoPafTxYkCk783Y0/edit#slide=id.g9cbb45789c\\_0\\_110](https://docs.google.com/presentation/d/17Eb57Ldgw35Q75_9dJlM7pHoDM9IoPafTxYkCk783Y0/edit#slide=id.g9cbb45789c_0_110)

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

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### 6.2 Learning Objective

I have two objectives for today. First, I want to explicitly go through the quiz with the class since they told me on the feedback form that they appreciate me explicitly working with the whole class together.

After that, I want to take another look at orbits and Kepler's Laws with a breakout roommate activity on "planet nine." I think this will be a really good challenge for them. I want them to come out knowing the generality of Kepler's Laws, and be able to do calculations with ratios using Kepler's Third Law.

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### 6.3 Lesson

- **Berkeley Time**
- **APOD: Sagittarius A\* Animation:** ~ 10 minutes
  - What do people think we are looking at? When I put the orbit and focus on, does that help?
  - But there isn't any central mass, so what is it? A black hole!
  - I have some facts on the screen to guide the discussion. Also there are two really great videos to accompany. I really like this week.
- **Any questions?:** ~ 10 minutes
  - Ask them if they had questions on the material from the past week. The topics were a mix of orbits and then atmospheres/the greenhouse effect.
  - This doesn't normally take the full 10 minutes, but I still want to give them some time.
- **Taking the quiz:** ~ 10 minutes

- Brief walk through of how I would have solved the problems/what to answer for the short response.
  - **Breakout Rooms:** ~ 10 minutes
    - Bring them back at the very end. I think I want to tell them to try the problem for next week, and then start next week's class with the problem. I will gauge how difficult they think it is/how far they get, I think.
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## 6.4 Reflection

The key takeaway from this class is that the breakout rooms did not work – I popped into their rooms a few times and no one was talking at all. I asked for some feedback on them in my feedback form, and they overwhelmingly suggested Kahoots, so I am going to try that for reviews here on out.

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## 7 Week 7 Lesson Plan

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### 7.1 Links

**Slides:** [https://docs.google.com/presentation/d/1CqtVfsmVgFLblPXmznFW5ja-mjxtzVkgU7H68qdFo7g/edit#slide=id.g9b9de18f6b\\_0\\_5](https://docs.google.com/presentation/d/1CqtVfsmVgFLblPXmznFW5ja-mjxtzVkgU7H68qdFo7g/edit#slide=id.g9b9de18f6b_0_5)

**Kahoot:** <https://create.kahoot.it/details/midterm-1-review/a67a51f9-d147-4471-b5b4-fe292271d1d3>

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

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### 7.2 Learning Objective

I prepared a larged Kahoot review this week since they have the midterm next week. I think this is much better for them than the typical breakout rooms (especially given their feedback), so I'm anxious to see how it goes.

I'll be happy if they can come away feeling prepared for the midterm on Friday!

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### 7.3 Lesson

- **Berkeley Time**
  - **APOD: Nobel Prize + Galactic Center (10 minutes)**
    - Nobel Prize announced for the work I talked about last week! Reinhard + Andrea, given a bit of the background
    - Legacy of Kepler as well to relate the course content to the APOD.
  - **Kahoot (30 minutes)**
    - Work out each problem and ask for questions!
  - **Open Questions (10 minutes)**
    - Last minute questions for the Midterm.
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### 7.4 Reflection

The Kahoot was wildly popular and received great feedback in the feedback form. There wasn't a single complaint about this class, so I think I'll keep the structure similar from here on out with midterm reviews.

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## 8 Week 8 Lesson Plan

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### 8.1 Links

**Slides:** [https://docs.google.com/presentation/d/11MaEyNRJ6IIYTSsRY6yanFF1uV2vYBIzFIjp4r0QC\\_I/edit#slide=id.ga1824339ae\\_0\\_70](https://docs.google.com/presentation/d/11MaEyNRJ6IIYTSsRY6yanFF1uV2vYBIzFIjp4r0QC_I/edit#slide=id.ga1824339ae_0_70)

**Kahoot:** <https://create.kahoot.it/details/october-15-16-review/4764bb37-2452-4fa5-9328-12dacbe69f22>

**Weekly Survey:** <https://forms.gle/hPRnNc8mpzRifzq97>

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### 8.2 Learning Objective

I want to highlight some basic properties of stars that they are familiar with (luminosity, color temperature) and extend to the inverse square law of brightness. I think if they come away knowing what a star is, what powers a star, and how to calculate parameters describing a star, it will be a successful class. I'll measure the success on the Kahoot performance and the scores on the quiz in two weeks.

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### 8.3 Lesson

- **Berkeley Time**
- **APOD: Virgo Cluster (10 minutes)**
  - All of the information is written out in the slides! Remember to relate this to EHT and the Nobel Prize last week.
  - There is also the video to play (on the journey through the Virgo supercluster). I think this would be worth it.
- **Review from the Previous Lecture (15 minutes)**
  - Brief reminder of the basic properties of stars, the HR diagram, the fundamental scaling relationships for stellar evolution. Tie this directly to the stuff we have seen in previous APODs.
  - Highlight specifically the things that are mentioned on the Kahoot so that they feel comfortable during.
  - If you have left over time, consider relating Wien's Law to the luminosity to distance. There is a really great quiz question hidden in there that can be done quickly.
- **Kahoot! (10 minutes)**

- Last minute questions for the Midterm that got rescheduled
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## 8.4 Reflection

This class felt incredibly rushed. I think that the students got a lot out of it; they said they enjoyed the split between lecture recap and hands-on application with the Kahoot, but on my end, I didn't have enough time for either the Kahoot or my lecture recap. I think I need to be less ambitious and cut down the time on the APOD to make this structure successful.

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## 9 Week 9 Lesson Plan

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### 9.1 Links

**Slides:** <https://docs.google.com/presentation/d/1Nhk2PhZg2z7UGt3NG1DePk-jyNqCskkqe0eXapJABS0/edit#slide=id.p>

**Kahoot:** <https://create.kahoot.it/details/quiz-2-review/66ed883e-97fe-4fd3-aedf-3d9b29279623>

**Midsemester Feedback Form:** <https://tinyurl.com/pilawaMidSemForm>

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### 9.2 Learning Objective

They have a quiz next week, so my goal is to prepare them for the quiz and the content that it will cover. This includes stars, orbits, and stellar evolution, but many students still are not comfortable with Wien's Law and the luminosity equation in practice. I designed the Kahoot to work on this, giving approximately the amount of time/length of questions that they might see on the quiz.

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### 9.3 Lesson

- Berkeley Time
  - APOD: Soap Bubble Nebula and Crescent Nebula (10 minutes)
  - Mid-semester Feedback Form (approx 15 minutes)
  - Quiz logistics and topics(5 minutes)
  - Kahoot review (20 minutes)
  - Last minute questions (10 minutes)
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### 9.4 Reflection

I am really getting into the swing of the semester. Nothing felt off about this week, and I think I was able to lesson plan efficiently and effectively for this class. They had great questions, they enjoyed the Kahoots, and I got great feedback from the mid-semester feedback form. There isn't too much I would change about this specific class!

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## 10 Week 10 Lesson Plan: Quiz 2!

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