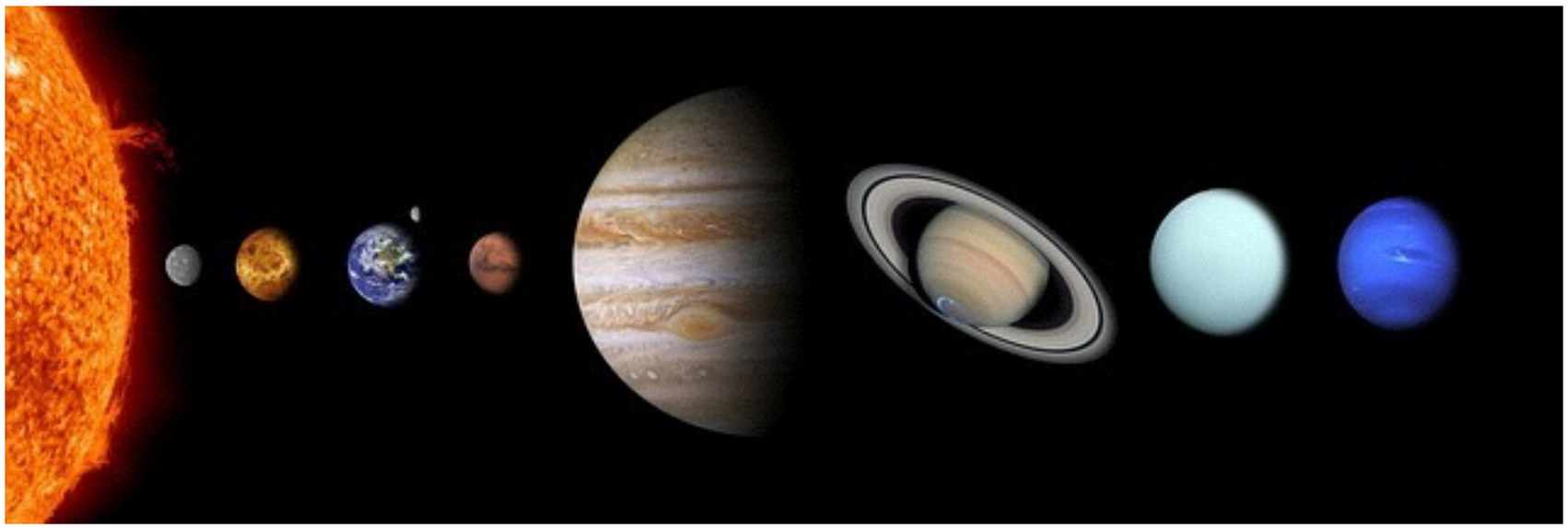
Paired teaching + Course transformation:



Incorporating active learning in Astronomy 101

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Goals of the project

1. **Professional development in teaching** for less experienced partner: learn and become confident in active learning strategies

2. **Incorporate active learning into Astronomy 101**

Paired Teaching at UBC

- Goal: Professional development in teaching for both instructors

- 2 instructors share responsibility for all aspects of course

- Weekly meetings (or more often) to plan and discuss teaching

- We alternate weeks that we teach

- Both always in the classroom

Course Overview

- “Introduction to the Solar System”
- First-year students
- Mostly science majors (not physics or astro)
- ~100 students
- 3 one-hour lectures / week
- 1 two-hour lab / week
- Taught for many years in (popular) pure-lecture style

Major Learning Goals

- Develop a life-long interest in astronomy
- Develop understanding of the scientific process
- Ask "Why" and "How do we know?"
- Develop your skills and mindset for evidence-based thinking

Active learning strategies

we incorporated in Astronomy 101

- Peer instruction via clicker questions
- Get students comfortable contributing in class
  - learn names, ask students to prepare to share, wait long time
- In-class worksheets
- Pre-class reading assignments (with online questions)
- Online discussion forum
- Two-stage (individual + group) midterms & final

Selected research references:

- Active learning: Freeman et al. (2014);
- Inclusive teaching: Tanner (2013);
- Pre-class reading: Heiner, Banet, Wieman (2014);
- Group exams: Wieman, Rieger, Heiner (2014);
- Research-based materials from Center for Astronomy Education & UNebraska

Our process

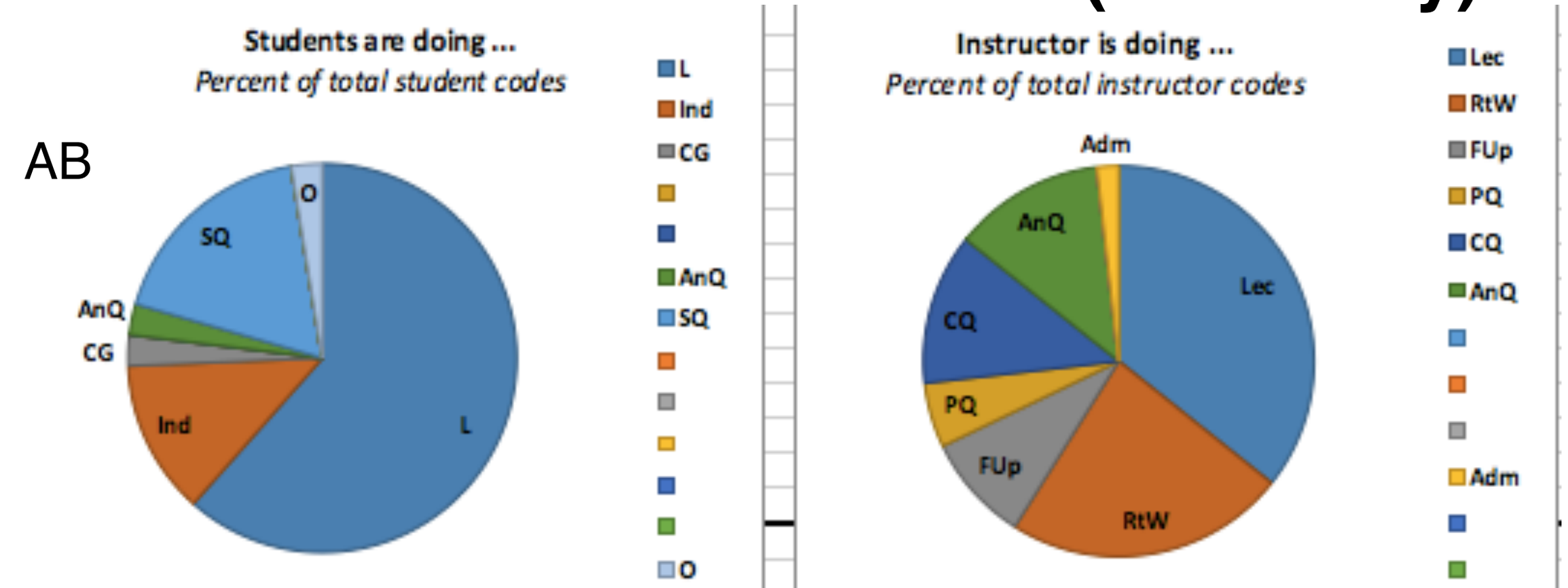
- Drafted learning goals together
- Challenge: Had to make most key decisions before course started:
  - textbook, HW format, exam format
- LS and AB (pair) alternated responsibility by topics / weeks

- What LS did each week:
  - read chapter
  - list key topics
  - draft extremely rough topic-level learning goals
  - decide on pre-class reading sections, pre-reading HW questions, in-class activities, post-class HW questions

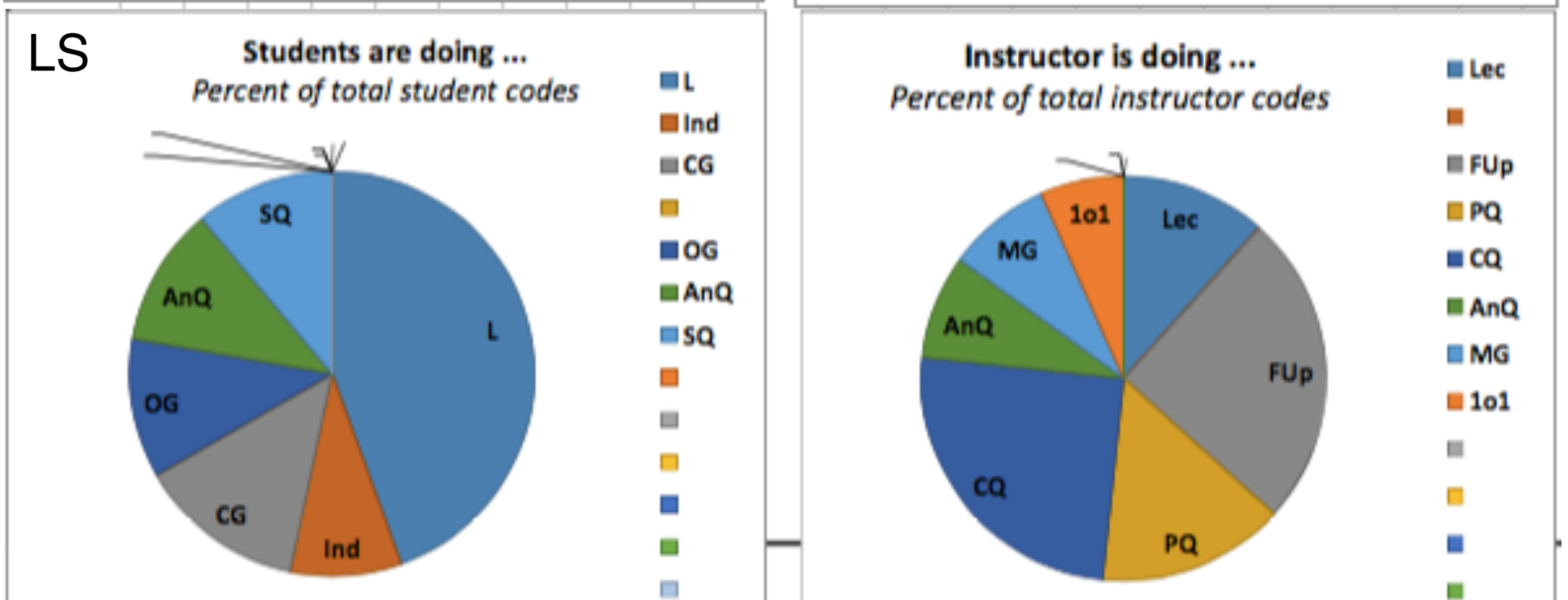
- Borrowed large amounts from Center for Astronomy Education (slides, ranking tasks) & UNebraska (clicker Q's, simulations)

Results: COPUS observations (2016 only)

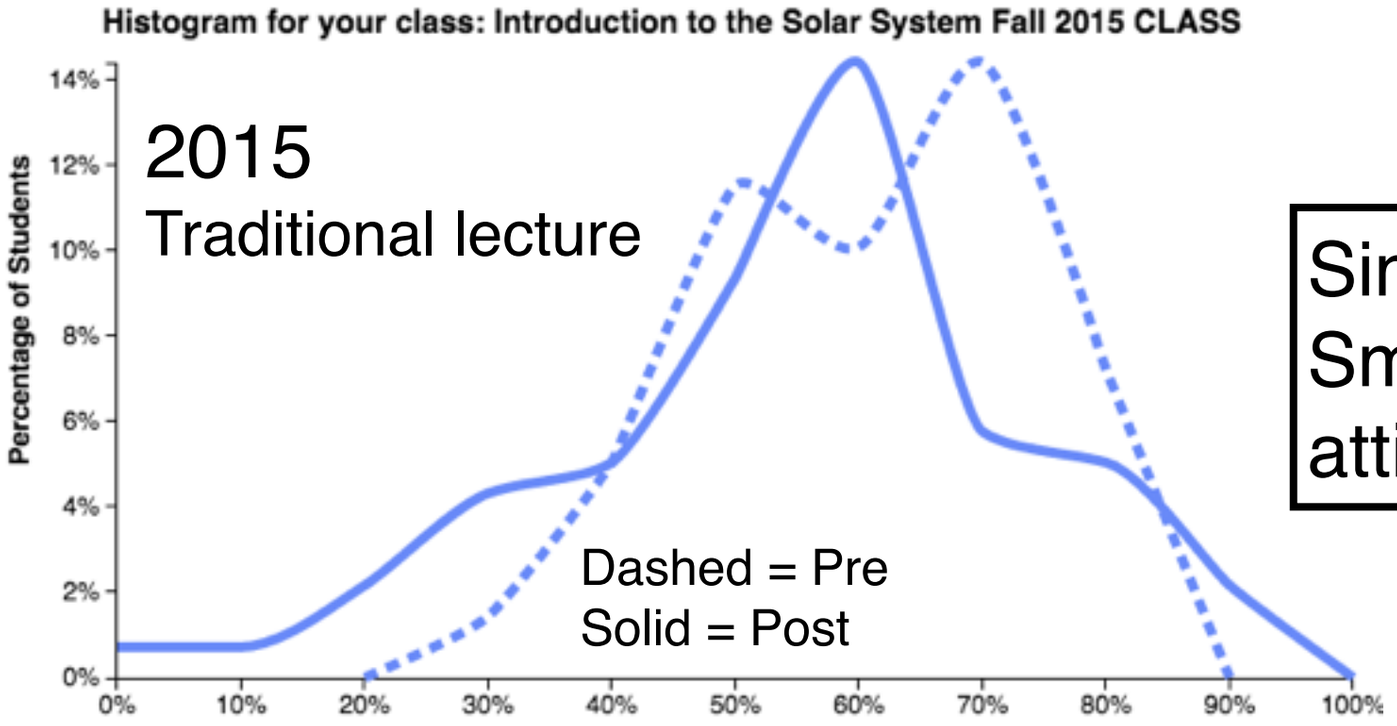
AB



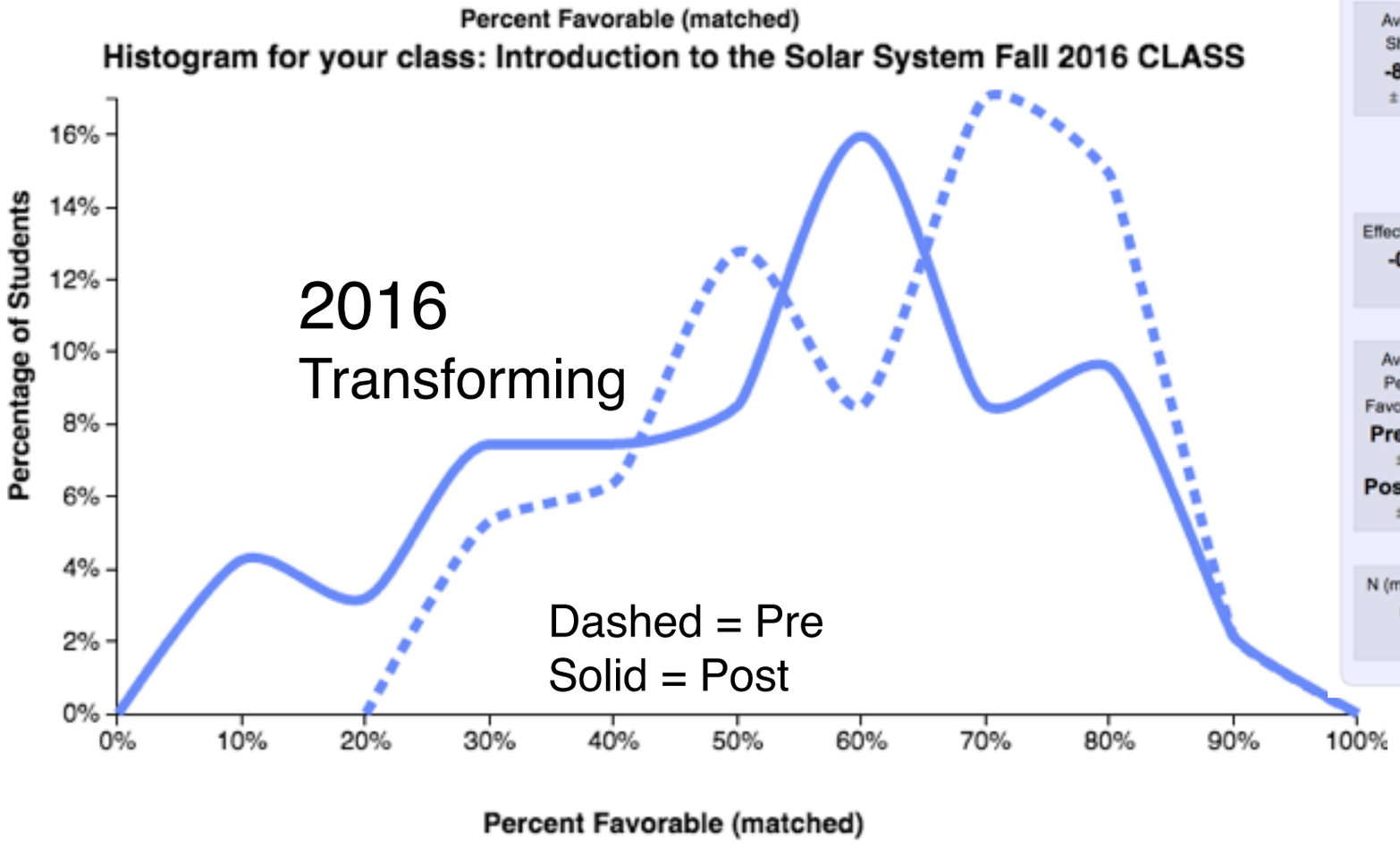
LS

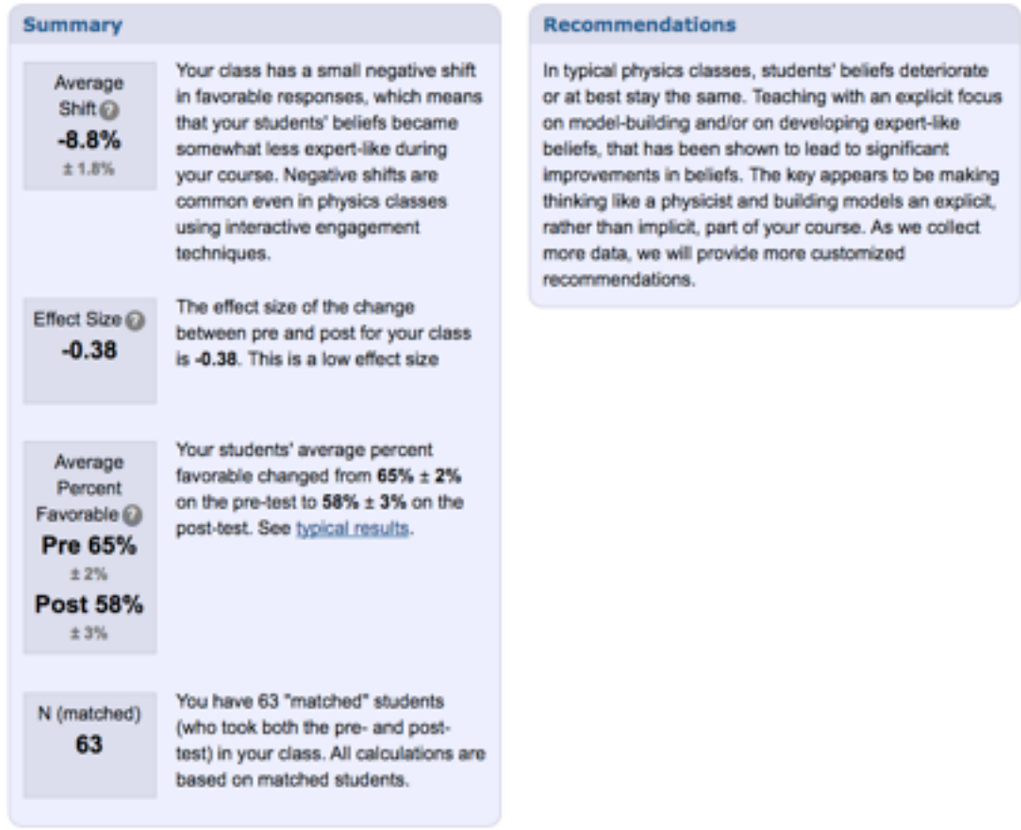


Results: Attitude survey (CLASS) (2015 and 2016)



Similar results in 2015 and 2016: Small negative shift in student attitudes





Summary

Average Shift: **-8.8%** ± 1.8%
Your class has a small negative shift in favorable responses, which means that your students' beliefs became somewhat less expert-like during your course. Negative shifts are common even in physics classes using interactive engagement techniques.

Effect Size: **-0.38**
The effect size of the change between pre and post for your class is **-0.38**. This is a low effect size

Average Percent Favorable: **Pre 65%** ± 2% **Post 58%** ± 3%
Your students' average percent favorable changed from **65%** ± **2%** on the pre-test to **58%** ± **3%** on the post-test. See typical results.

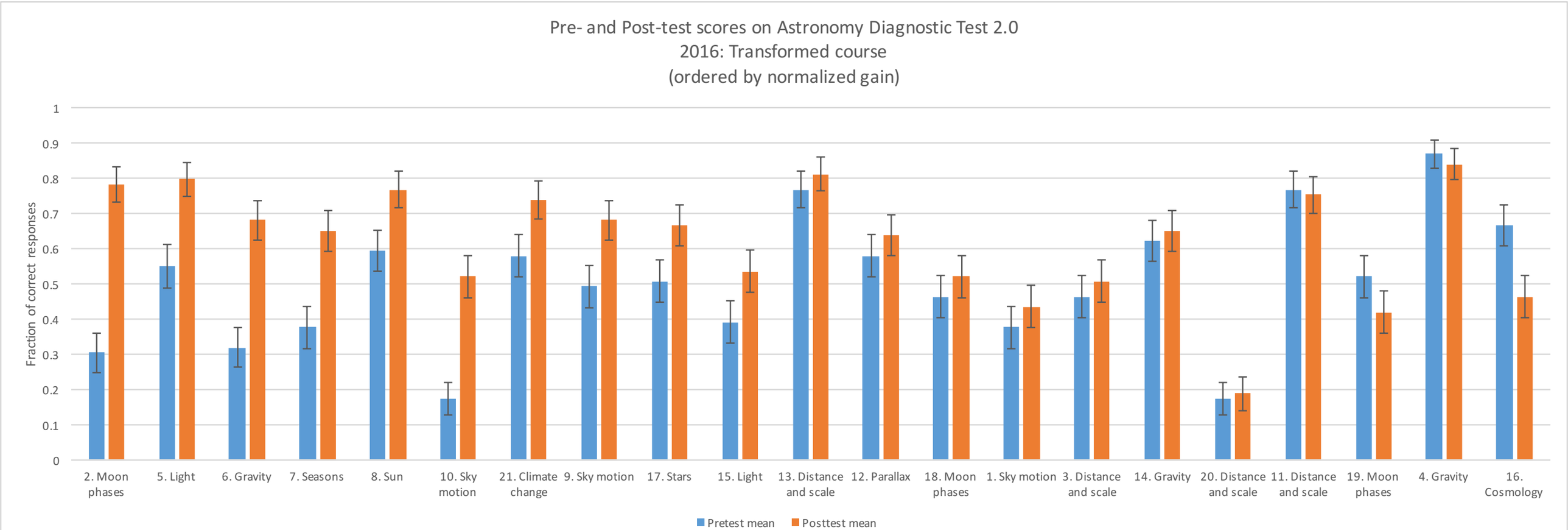
N (matched): **63**
You have 63 "matched" students (who took both the pre- and post-test) in your class. All calculations are based on matched students.

Recommendations

In typical physics classes, students' beliefs deteriorate or at best stay the same. Teaching with an explicit focus on model-building and/or on developing expert-like beliefs, that has been shown to lead to significant improvements in beliefs. The key appears to be making thinking like a physicist and building models an explicit, rather than implicit, part of your course. As we collect more data, we will provide more customized recommendations.

(Analysis by Physport)

Results: Astronomy Diagnostic Test 2.0 (2016 only)



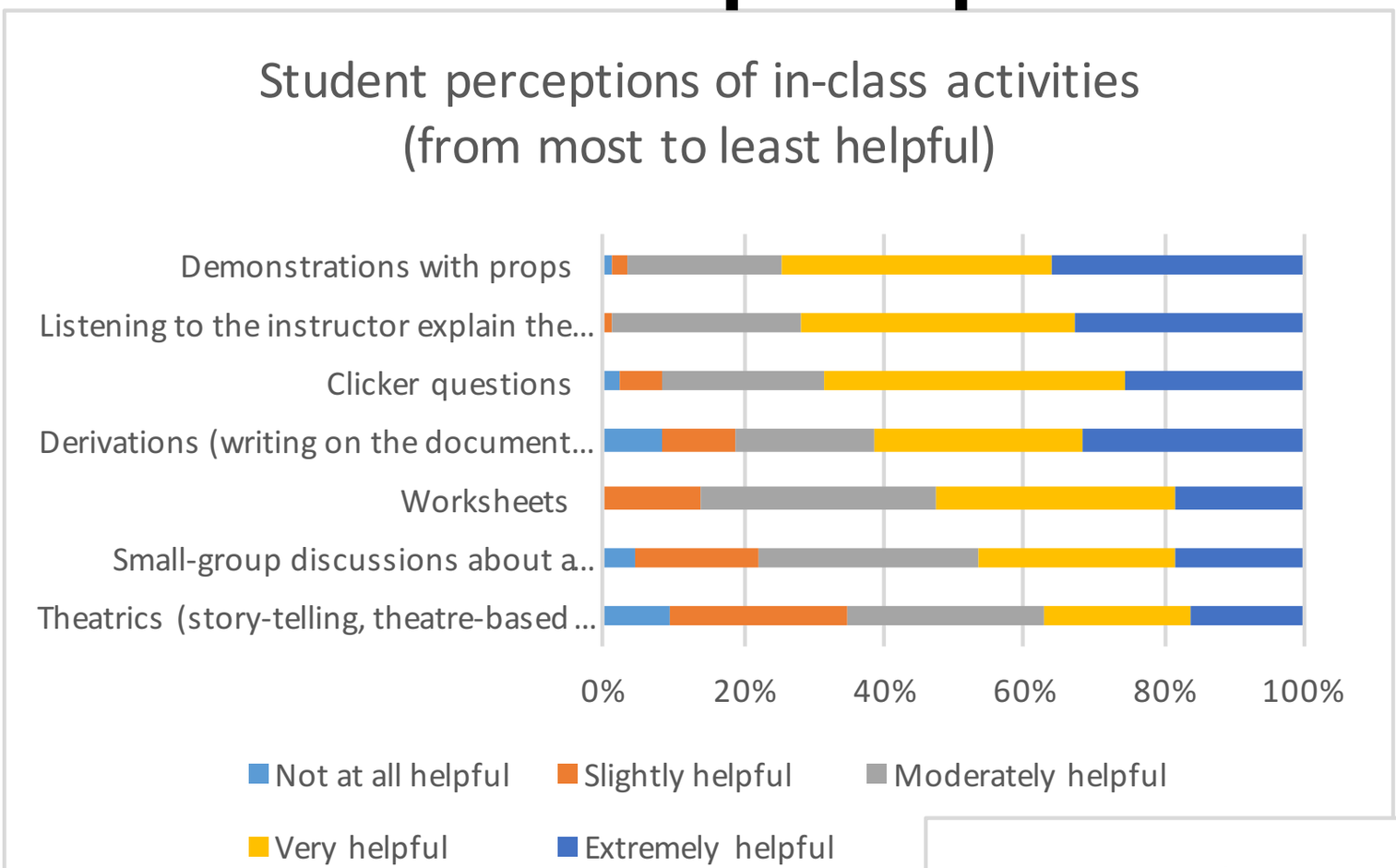
Mean fraction correct on pre-test = 0.503 +/- 0.013
Mean fraction correct on post-test = 0.622 +/- 0.013

Mean normalized gain = 0.239

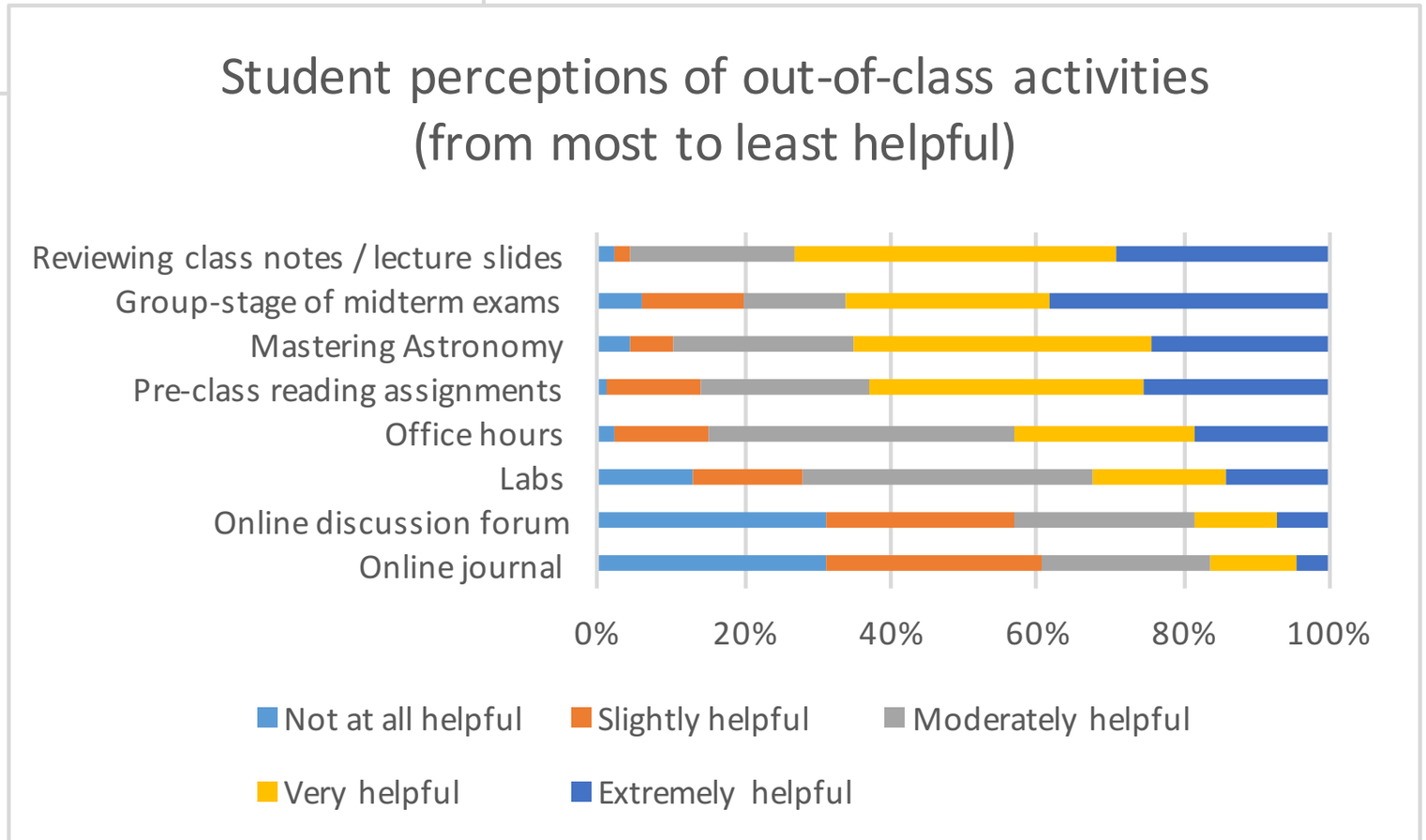
ADT 2.0 written by Collaboration for Astronomy Education Research (2004)

(No data available for 2015)

Results: Student perceptions of class activities (2016 only)



"Please indicate how helpful you found the following class elements of ASTR101 -- for learning astronomy, or skills useful for other science courses."



Challenges

- Support / long-term planning at dept level has been unclear (though improving now)
  - No observations of previous untransformed course
  - Vision for pair and for transformation
  - Future teaching assignments?
  - Future astronomy transformations?

- Not enough time:
  - to discuss lesson plans days before class
  - to digest, analyze and incorporate results from students through the term

Next steps : Transform Lab Curriculum

- **AB will teach Astronomy 101 lecture alone in Fall 2017**

- **We plan to begin lab transformation in Fall 2017:**
- Currently: Linear step-by-step lab activities

- Plan to introduce **inquiry-based labs** to focus on scientific thinking

"What changes to the labs would improve your learning in ASTR101?"