Transforming Introductory Astronomy: From Learning Goals to Instruction and Assessment

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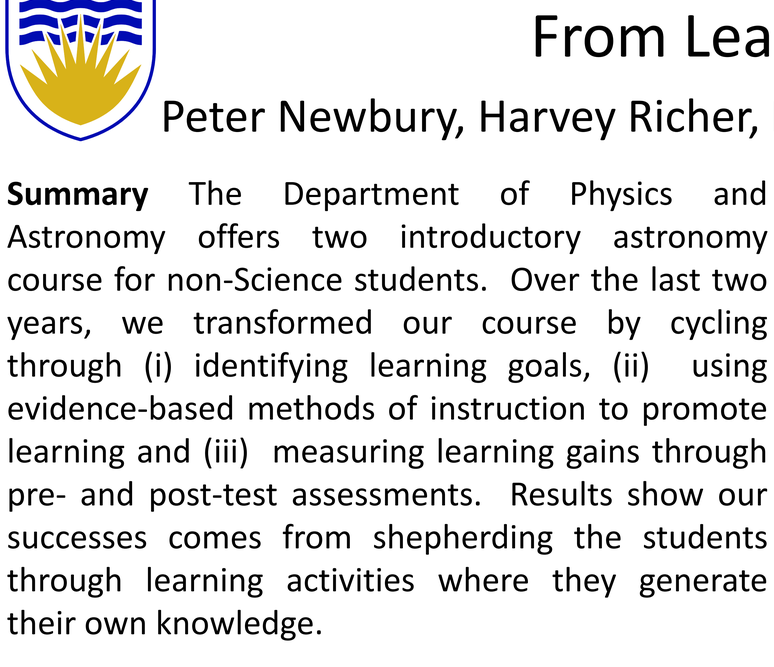
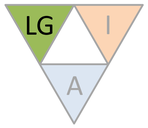
Summary The Department of Physics and Astronomy offers two introductory astronomy course for non-Science students. Over the last two years, we transformed our course by cycling through (i) identifying learning goals, (ii) using evidence-based methods of instruction to promote learning and (iii) measuring learning gains through pre- and post-test assessments. Results show our successes comes from shepherding the students through learning activities where they generate their own knowledge.

Course description Students in ASTR 310 (Exploring the Solar System) and ASTR 311 (Exploring the Stars and Galaxies), roughly 300 per term, attend three 50-minute lectures each week and one 50-minute lab every other week. We concentrated our efforts on creating hands-on activities for these labs. The design of the activities is based on three pillars:

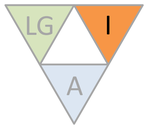


Alongside each activity, we create a guide for TAs and instructors which outlines the steps to run the activity and, whenever possible, the pedagogical justification for these steps.

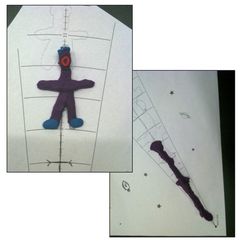
ASTR 311: Black Holes

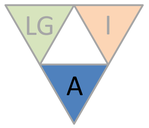


Describe what you would see and feel if you fell into a black hole.



After exploring the origin of tidal forces, students track the motion of an astronaut who falls into a black hole and gets "spaghettified".

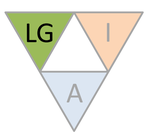




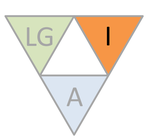
Q8: An astronaut falling feet-first into a black hole is stretched out and "spaghettified" because the

- ☐ pull of gravity on his feet is much greater than the pull on his head
- ☐ black hole's rapid rotation stretches him
- ☐ magnetic field pulls strongly on his boots
- ☐ electric field pulls oppositely charged particles in opposite directions

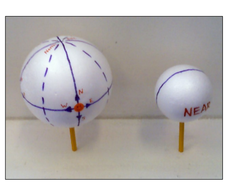
ASTR 310: Phases of the Moon

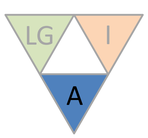


Reproduce the geometry of the Earth, Moon and Sun to illustrate the phases of the Moon and to predict rise/set times.



Students hold Moon and Earth balls in a darkened room with one bright, central light to reproduce phases of the Moon, spin Earth to find Moon rise and set for each phase.

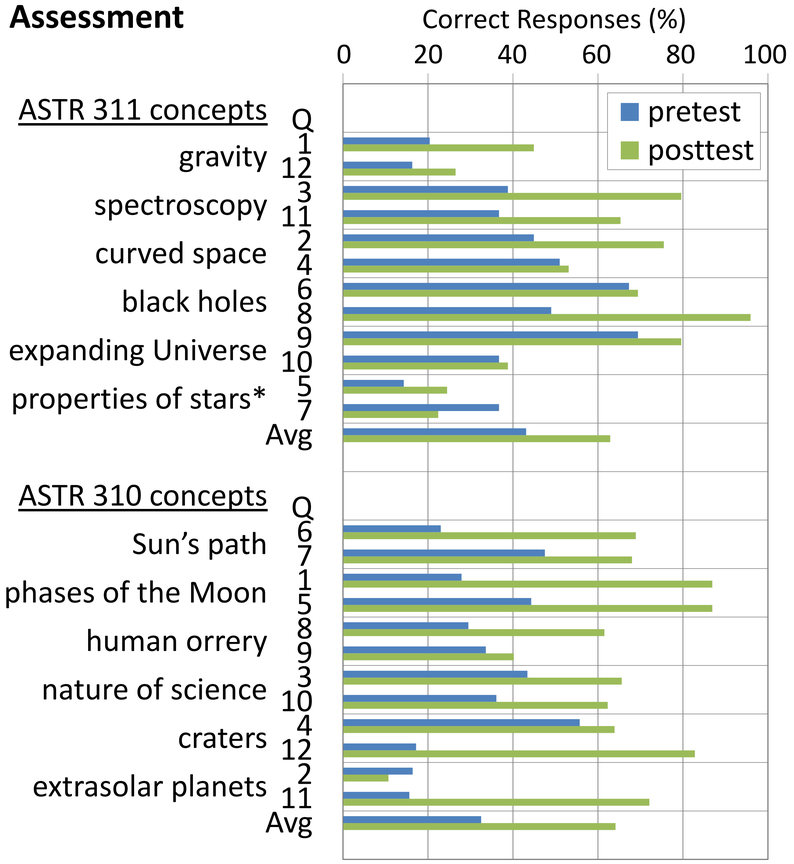




Q5: The Moon is full today. If you go outside at noon and the sky is clear, can you see the Moon?

- ☐ No, you can never see it during the day
- ☐ No, Moon is below horizon
- ☐ Yes, Moon is up

Assessment



	N (pairs)	Pretest mean	Std err	Posttest mean	Std err	Learning gain
ASTR 311	48	42.3%	2.7%	62.5%	2.7%	0.33
ASTR 310	122	32.5%	1.4%	64.1%	1.6%	0.46

Discussion and Further Work After drafting learning goals, we identified the goals best addressed by hands-on activities. The learning gains of 0.32 and 0.46 indicates these activities are moderately successful at promoting learning. We continue to improve the activities and the survey we use for the pre- and post-tests. In the future, we turn our attention to transforming the lectures into an active learning environment by using Clickers, Lecture-Tutorials and other in-class activities to engage the students so they can generate their own knowledge.

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