First Attempt At Assessing Astronomy 0089: Stars, Galaxies and the Cosmos

Regina Schulte-Ladbeck
Professor and Chair, Undergraduate Program Assessment Committee
Department of Physics & Astronomy, University of Pittsburgh
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What is Assessment and Why Do We Have to Do It?

- Accreditation
- Middle States Association's Commission on Higher Education (MSCHE)
- MSCHE has 14 accreditation standards
- Standard 12: General Education
  - "The institution's curricula are designed so that students acquire and demonstrate college-level proficiency in general education and essential skills, including at least oral and written communication, scientific and quantitative reasoning, critical analysis and reasoning, and technological competency."

What is Assessment and Why Do We Have to Do It?

Assessment Cycle

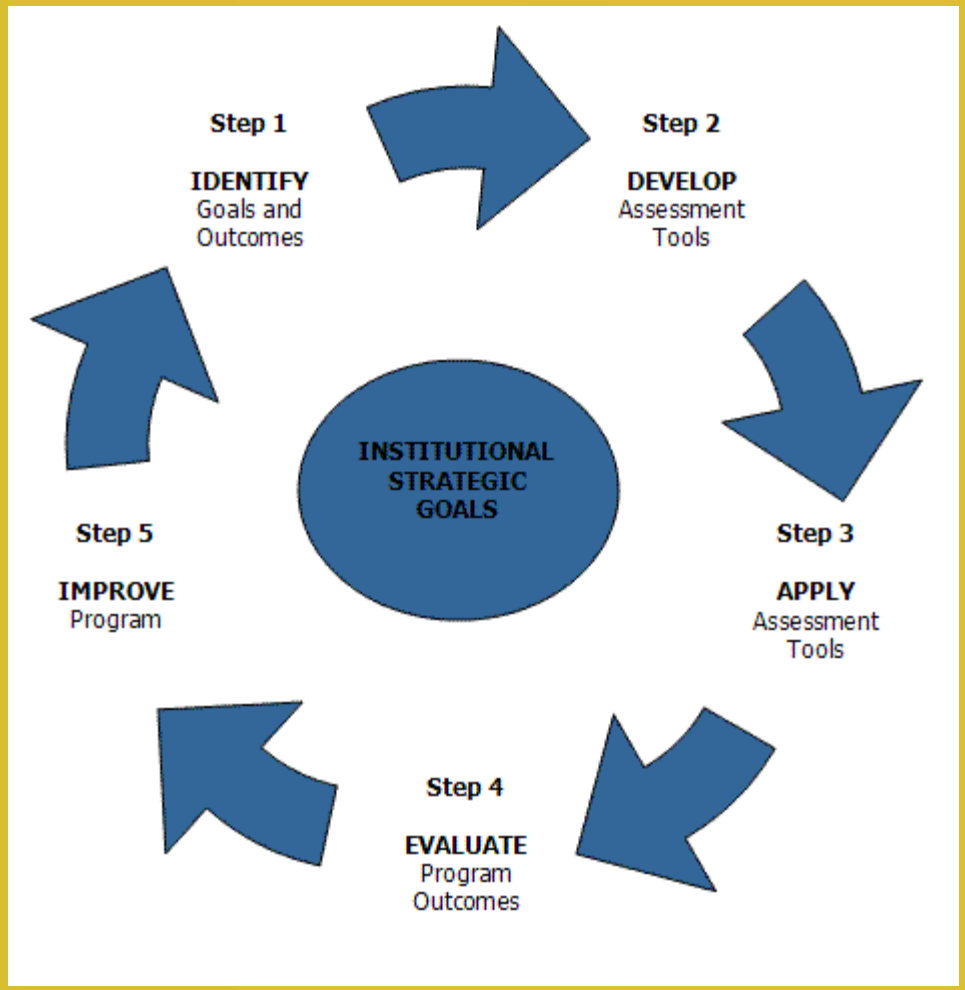

Image credit: www.umhelena.edu/.../CommonFiles/assessment.gif

What is Assessment and Why Do We Have to Do It?

- 2006: Provost Office developed an assessment process for University of Pittsburgh provost.pitt.edu/assessment/index.html
- 2007: Deans of Arts and Sciences developed process for assessing general education courses in A&S
- 2008: A&S Undergraduate Council selected Astron 0089 as a course to be sampled
- 2008: Astronomy faculty discussed and implemented assessment for Astron 0089
- 2009: Submitted first results to Dean’s office

A&S Instructions

- Identify 3-5 learning objectives for the course
- Assessment techniques could include
  - Embedded questions within tests
  - Sampling of students to participate in a faculty interview
  - Faculty review of a sampling of student papers
  - Purchase or create a test that measures the outcomes
- Implement the assessment
- Report the assessment using assessment matrix
- Submit to Associate Dean for Undergraduate Studies for review by A&S-UC

Physics and Astronomy Process

- Student Learning Outcomes: Benchmarking

  Used the American Astronomical Society's

  Goals for "Astro 101": Report on Workshops for Department Leaders

  http://aas.org/files/101-FinalReport.pdf

Physics and Astronomy Process

Astro 101 students should gain:

- a cosmic perspective--a broad understanding of the nature, scope and evolution of the Universe, and where the Earth and Solar System fit in
- an understanding of a limited number of crucial astronomical quantities, together with some knowledge of appropriate physical laws
- the notion that physical laws and processes are universal
- the notion that the world is knowable, and that we are coming to know it through observations, experiments and theory (the nature of progress in science)
- exposure to the types, roles and degrees of uncertainty in science
- an understanding of the evolution of physical systems
- some knowledge of related subjects (e.g., gravity and spectra from physics) and a set of useful “tools” from related subjects such as mathematics
- an acquaintance with the history of astronomy and the evolution of scientific ideas (science as a cultural process)
- familiarity with the night sky and how its appearance changes with time and position on Earth.

Physics and Astronomy Process

Astron 0089 Learning Outcomes:

- Students will be able to defend the notion that the Universe is comprehensible, and that we are developing this knowledge through observations, experiments, theories and models.
- Students can assess the types, roles and degrees of uncertainty in astrophysical science.
- Students will recognize that scientific ideas have evolved in general, and specifically, how this has occurred in astronomy and astrophysics.
- Students can cite examples which demonstrate that physical laws and processes are universal.
- Students will be able to recognize and manipulate mathematically, a limited number of crucial astrophysical quantities that have shaped our understanding of the nature, scope and evolution of the Universe.

Physics and Astronomy Process

- Assessment technique: embedded questions
  - Fits how we test students using multiple-choice exams in this large enrollment, multiple sections course
- Embedded questions: rules
  - Instructor **must** give at least one question for each of the 5 learning outcomes
  - No standardized questions across sections (i.e., allow instructor of the section to pose the questions)
  - Instructor may use any in-class exam (not just the final)
  - Instructor **must** give 5 answer choices (a-e)
- Standard: baseline for declaring success
  - >70% of students chose the correct answer

Physics and Astronomy Process

- What does standard *really* mean?
- Assume: all 5 answers equally appealing
  - 20% of students guess right answer by chance
- Given: Standard is more than 70% got it right
  - If 70% checked the right answer, we can only be sure that at least about 62% really knew the right answer
  - 76% of right answers are needed to be sure that 70% knew the answer

Physics and Astronomy Process

- First assessment attempt
  - Fall of 2008
  - Three sections of Astron 0089 offered
  - Two of these were lecture-type sections to A&S undergraduates, taught by the same instructor
    - Both sections were assessed
    - Results are reported here
  - One section was an on-line class for CGS, taught by another instructor
    - This section was not assessed
      - Different teaching methodology
      - <10% of total enrollment

Test Questions Used

1. Students will be able to defend the notion that the Universe is comprehensible, and that we are developing this knowledge through observations, experiments, theories and models.

Q. Which of the following observations is not evidence for the Big Bang Theory of the Universe?

A. the formation of structure (galaxies and clusters of galaxies)
B. the redshifts of galaxies (Hubble's Law)
C. the cosmic microwave background
D. the presence of supermassive black holes in the centers of galaxies
E. the cosmic abundance of H and He

Test Questions Used

- The correct answer is D.
- Of the 295 students who answered this question, 248 (**84%**) answered it correctly.

Test Questions Used

2. Students can assess the types, roles and degrees of uncertainty in astrophysical science.

Q. A measurement of 72 +/- 8 km/s/Mpc for the Hubble constant means that

A. galaxies increase or decrease their velocity by 72 km/s for every 8 Mpc.

B. it varies between 64 and 80 km/s/Mpc depending on distance.

C. our measurement is uncertain by about 10%.

D. our observations are incorrect.

E. the Hubble constant is sometimes 64 and sometimes 80 km/s/Mpc.

Test Questions Used

- The correct answer is C.
- Of the 295 students who answered this question, 180 (**61%**) answered it correctly.

Test Questions Used

3. Students will recognize that scientific ideas have evolved in general, and specifically, how this has occurred in astronomy and astrophysics.

Q. In 1915, Einstein modified Newton's description of gravity. Which of these statements is correct?

A. Newton described gravity as a force that acts instantaneously between objects with mass while Einstein described gravity as a curvature of space time due to the presence of mass.

B. In Newton's theory, light travels along straight lines while in Einstein's theory it travels along curved paths, but faster.

C. Newton's theory works only on small scales like planets, while Einstein's theory works only on scales larger than galaxies.

D. Newton's gravity was universal while Einstein's theory only explained the behavior of light near black holes.

E. Newton's force of gravity explained dark matter and Einstein's theory of gravity explained dark energy.

Test Questions Used

- The correct answer is A.
- Of the 295 students who answered this question, 271 (**92%**) answered it correctly.

Test Questions Used

4. Students can cite examples which demonstrate that physical laws and processes are universal.

Q. Many of the concepts that we have learned in this class are based on the notion that physical laws and processes are universal. Which of these statements conform to this idea?

A. A Cepheid variable in our Galaxy is found to have a period of 10 days and a mean luminosity of 1000 L(sun). Therefore, if a Cepheid variable star of the same period is found in the galaxy M101, it must be just as intrinsically bright.

B. The fusion of H to He in the early Universe must have occurred in the same manner as it does in the Sun because the temperature and density were the same in the early Universe as they are in the Sun now.

C. The force of gravity that keeps the Earth in orbit around the Sun is the same force that keeps the Sun in orbit around the Galactic center.

D. All of the above conform to this idea.

E. Once A and C conform to this idea.

Test Questions Used

- The correct answer is D.
- Of the 295 students who answered this question, 128 (**42%**) answered it correctly.
- Note: Instructor thought this question was more difficult than others.

Test Questions Used

5. Students will be able to recognize and manipulate mathematically, a limited number of crucial astrophysical quantities that have shaped our understanding of the nature, scope and evolution of the Universe.

Q. Increasing the temperature of a blackbody by a factor of 3 will increase its energy output by a factor of

A. 3

B. 6

C. 9

D. 12

E. 81

Test Questions Used

- The correct answer is E.
- Of the 309 students who answered this question, 229 (**74%**) answered it correctly.

Review of Results

- Undergraduate Program Assessment Committee
  - students met standard for 3 of 5 learning outcomes
  - the standard should be kept, as it appears both attainable and challenging
  - may be useful to have more assessment questions

Review of Results

- Agenda for today's discussion
  1. Learning outcomes?
  2. Assessment technique?
  3. Assessment result?
  4. Syllabus?
  5. Other issues?

1. Learning Outcomes?

- The learning outcomes are good. We decided that we should keep them.

2. Assessment Technique?

- The assessment technique was not good. The learning outcomes we state are all about students' ability to explain broad ideas. This is at best extremely difficult to assess using multiple choice Q&As, and perhaps impossible.
- If our goal is to find out whether students can actively explain astronomical concepts then a better way to test that would be
  - Select a sample of students who took the class
  - Have them explain the broad ideas to other students
  - Observe them and assess how well they can do it.
- A drawback is that this assessment would be very resource intensive.

3. Assessment Result?

- The results are insufficient.
- They do not provide us with actual guidance about how to improve the course.
- We need to come up with a smart way to get answers that help us improve student learning.

4. Syllabus?

- When the course was started two decades or so ago, it was not designed to fit the learning outcomes that we articulated in the summer of 2008.
- It was designed to be a phenomenological course, to cover a wide range of facts in a survey mode.
- Consensus of the “Goals for Astro 101” report was “less is more”, cut back on facts. Teach broad ideas, concepts.
- Consensus among Pitt faculty is teach how we know what we know, how science works, is done.

5. Other Issues?

- The course is popular. We need to continue to teach topics that students are interested in, lest we loose enrollment, and thus our impact on science education at Pitt. But we also want to teach the course in a way that helps students learn about broad ideas in science.
  - We need to re-develop the course to fit our goals.
- There are no resources for assessment or for course development.
  - Whatever we do must be smart, i.e., have maximal impact at minimal cost.

5. Other Issues?

- There are no rewards for doing better. If anything, whoever puts time into it will be “punished”.
  - IDEA: Assign all sections to one instructor for a year. With the time saved by not having to teach different classes, ask this person to make incremental headway in re-designing the course. After the year is up, instructor gets time off from teaching, someone else takes over the course development.
- There is no book that caters to the model of teaching broad ideas, rather than surveying the phenomena.
  - We should review recent books (AZ thought he’d seen a good one – 21st Century Astronomy by Hester et al.).

Conclusions

- Smarter test would be a pre/post test.
- For each learning outcome, have a few (3?) well developed multiple-choice Q&A. Use this test in all of the sections of ASTRON 0089 next year.
- Over the summer, faculty read literature, find out how far other's have gotten in designing an instrument for Astro 101. Faculty design/adapt the pre/post test for Pitt/ASTRON 0089.
- We begin using the pre/post test in fall of 2009.
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to consider giving teaching assignment to one person.

These notes will be posted on

phyast.pitt.edu/~rsl/rsl.html