Facts of Life for New Teachers in the Astronomy Non-majors Curriculum*

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Facts of Life for New Teachers in the Astronomy Nonmajors Curriculum

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Abstract

This is a guide to the most pertinent or difficult practical issues that confront new teachers in the astronomy nonmajors curriculum at large colleges and universities. It covers topics such as course design and infrastructure, required effort, special considerations in nonmajors teaching, classroom performance, use of visual presentations and the Web, interactions with students, interactions with faculty research, and many details of recommended practice in the face of constraints imposed by the quality of students and the amount of institutional support.

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XII. Assignments, Innumeracy, Quantitative Work, Critical Thinking
   A. Expected Work
   B. Science Literacy and Innumeracy
Here’s your situation as a new teacher in the non-majors astronomy curriculum!

1. You don’t know the subject
2. You don’t have any teaching skills
3. There’s nobody to help you

(Have A Nice Day!)
#1: There is no agreement on what constitutes good teaching

- ... on what students ought to learn or how well
- ... on how to evaluate good teaching
#2: Astronomy departments are ~unique among disciplines in the fraction of effort devoted to elementary non-majors courses.

- Majors represent $<\sim 3\%$ of typical astronomy department enrollments
- Your salary depends on large non-majors enrollment
- Most of your teaching effort will not be directed at training or recruiting future scientists
#3: Your students will be the **least prepared** of any in your university for your courses

- Effectively by definition, they will be below the 50\textsuperscript{th} percentile in math/science aptitude.
- Huge disconnect between content and audience.
#3a: Key Corollary. To communicate, you will have to **retrain your brain** and learn to **translate** the way you think into a ninth-grade conceptual universe.

Get yourself a new brain
#3a: Key Corollary. To communicate, you will have to retrain your brain and learn to translate the way you think into a ninth-grade conceptual universe.
Other Corollaries

#3b: It is HARDER to teach an ELEMENTARY course than a graduate course

#3c: It is HARDER to teach a course WITHOUT mathematics than with it
Welcome to basic astronomy. Are there any questions?

Yeah, like what makes astronomy different from astrology?

Lots and lots of math.
#4: Beginning teachers of elementary astronomy courses DON'T KNOW THE SUBJECT!

- Elementary courses: broad and shallow
- Professional training: narrow and deep
  - Typically little exposure to areas like history, planetary astronomy, solar astronomy, exobiology, stellar astrophysics (these days), etc
- Many noble goals of first-time teachers evaporate as this fact sinks in
Your Friend, the Textbook?
The Textbook: Threat or Menace?
Table 3-2  |  Total and Annular Eclipses of the Sun, 2006 to 2016**

<table>
<thead>
<tr>
<th>Date</th>
<th>Total/Annular (T/A)</th>
<th>Time of Mideclipse* (GMT)</th>
<th>Maximum Length of Total or Annular Phase (Min:Sec)</th>
<th>Area of Visibility</th>
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<td>12h</td>
<td>7:09</td>
<td>N.E. of S. America, Atlantic</td>
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<td>2:14</td>
<td>S. Pacific, Antarctica</td>
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<td>S. Atlantic, Indian Ocean</td>
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<td>Asia, Pacific</td>
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<tr>
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<td>7h</td>
<td>11:10</td>
<td>Africa, Indian Ocean</td>
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<tr>
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<td>T</td>
<td>10h</td>
<td>2:47</td>
<td>N. Atlantic, Arctic</td>
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<tr>
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<td>4:10</td>
<td>Borneo, Pacific</td>
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<td>9h</td>
<td>3:06</td>
<td>Atlantic, Africa, Indian Oc.</td>
</tr>
</tbody>
</table>

The next major total solar eclipse visible from the United States will occur on August 21, 2017.

*Times are Greenwich Mean Time. Subtract 5 hours for Eastern Standard Time, 6 hours for Central Standard Time, 7 hours for Mountain Standard Time, and 8 hours for Pacific Standard Time.

**There are no total or annular eclipses of the sun during 2014.
#5: The Textbook: Threat or Menace?

- Beautiful but flawed
- Students never like them
- Most are hyper-inclusive & contain vastly more material than anyone could or should be expected to absorb. But your students don't know that.
- You must carefully consider what parts to cover and tell students what to IGNORE
- So, you have to read the damn thing (350-400 fact-packed pages per semester)
#6: Increasing emphasis on electronic elements in teaching: a high cost/benefit ratio

- Complex; long learning curve; very time-consuming (can you say “PowerPoint”?)
- Perpetual revisions needed because of commercial/institutional imperative for "improvement"
- Introduce many possible single-point failures to classroom teaching
Corollary: College teaching is becoming hostage to corporate control.
#7: There is ~no academic "middle management"

- Academic programs are **self-administered** by the faculty.
- **Example**: UVa Arts & Sciences
  - 1100 instructors & staff
  - $200M annual budget
  - 5,000,000 student-hours of instruction per year
  - 25 FTE academic managers (all faculty)
- A direct consequence of the **tenure system**, which **selects** for people who (ideally) don't need supervision
Absence of Middle-Management

• **Pros**
  – Freedom from management interference, petty accountability, annoying incompetence
  – Lower cost for students (30%?)

• **Cons**
  – NO HELP! No significant support for teaching infrastructure, documentation, course management
  – You are ~ totally on your own for developing all aspects of your courses
  – (Note: this is the antithesis of the corporate operating model)
Implications

- You must make **scores of decisions** as you design a new course. These will determine how much effort will be required. But you will have little expert help in framing them.
#8: Your first defining decision is your “target audience”

- How inclusive will your teaching be?
- Target audience: the fraction of your class expected to achieve fairly easy comprehension of the material
- Non-majors exhibit a huge range in aptitude
- A course designed for 100% inclusion will be very different from one designed for the best 50%
- Persistent tension between better & poorer students.
  - Better students: dislike pandering to poorer students
  - Poorer students: resent better students
#9 Other Key Issues in Course Design

- You should deliberately "underschedule"
- Grading effort is a key consideration in designing assignments
- Quantitative reasoning/critical thinking? Think twice.
  - Best approach: term papers on allied topics
- Design to avoid the “Tyranny of the Gaussian Tail”
- Design for a 5 year period
  - You cannot afford the time for major revisions on a shorter timescale
  - You will quickly become unreceptive to the endless stream of teaching reform movements
#10**: Good teaching takes much more effort than you expect

Let's estimate the **EFFORT MULTIPLIER** --- i.e. the ratio of TOTAL to IN-CLASS effort for a one-semester, "3-hour" non-majors course
Portent #1

- **Student/Faculty ratio?**
  - S/F ~ 12-30 in public universities.
  - Hey, not too bad!
  - Oops! Forgot conversion from full-time to "3-hour" students per semester. That's 1:5, so....
  - Effective S/F ~ 60-150 each semester.
  - That's 2-5 courses per semester @ 30 stu/class OR 1 course @ 60-150 stu/class
  - Hmm....big classes here we come!
Portent #2

• The Churchillian standard
  – It took Winston Churchill 8 hours to prepare a 40-minute speech.
  – A 12:1 ratio of preparation to delivery effort
  – Churchill had 2-3 paid assistants.
  – He was smarter than most college professors.
Portent #3

• The Lewin-ian Standard
  – Walter Lewin, famous physics lecturer at MIT
  – Videos of his lectures are big YouTube hits
  – Lecture preparation time?
    • 40-60 hours
    • Including up to 3 real-time rehearsals
Portent #4

- Unlike Churchill or Lewin, you start almost empty-handed.
- Here’s a self-test:
  - How many hours of relevant, level-appropriate material could you confidently deliver extemporaneously to non-majors right now?
  - Call that "X". In preparation for a single, one-semester class, you will need to prepare only another 40-X hours of material.
Portent #5

- 50-min lecture ~ 5000 words = "term paper"
- 1 month of class = 12 term papers
Portent #6

• "Tyranny of the routine"

• Local example: Clark 107 is 1/4 mile away
  – If you spend 20 min walking to class and setting up...
  – That's 120 min = 2 hours per week
  – Which is 28 hours = 3.5 working days per class per semester (5% of your time) simply in transit

• Routine tasks in teaching are very time-consuming but are usually overlooked in estimating total effort
Portent #7

• Your students have no inherent interest in or motivation for learning the subject

• The popular solution?
... Show Biz!

- Brush up your comedy bits, song & dance routines, etc
- If you don't have any, make some up
- “Engagement” costs you yet more effort
Yes, non-majors teaching is a **performance art** and has much in common with **theater**

- **Even the ticket prices:**
  - Mean gross revenue per UVa undergrad: $20K/yr
  - Students take 10 3-hour courses/yr
  - ===> $2000/course
  - ===> $50 per class meeting (~40 meetings)

- **NB:** total annual revenue generated by a 100 student class is ~ $400,000. Think about that. Compare to faculty salaries.
#10a: Weekly Effort Estimate for a Mature "3 Hour" Non-Majors Course

- 3 hours in class
- 6 hours class prep (lecture notes, A/V, demos, in-class exercises) & rehearsal
- 3 hours course infrastructure (web pages, textbook reading & topic research, syllabus, prep of supplementary material, reading assignments, designing homework & student projects, examinations prep, gradekeeping s/w, etc)
- $N_{stu}/50$ hours enrollment-dependent effort (student conferences/communication, grading, special meetings—e.g. reviews, TA management). Assumes objective exams and grader support.

**TOTAL (for 150 students): 15 hours per week**

**Effort ratio:** $\text{TOTAL/IN-CLASS} = 5:1$
#10b: Implications

- Vast majority of effort in teaching is outside the classroom.
- Effort is governed more by number of courses taught than by number of students taught (in non-majors science courses).
- Greater than 500 hours of effort to develop a "mature" course.
- First-time effort ratio for new teachers? ~8-10:1, or 25-30 hours/week per course.
- Upgrades/revisions (typically 5 year intervals; e.g. new text or supplementary materials, A/V or software upgrades, new course management systems, new assignments or in-class exercises): add 1-2 hours per class meeting.
- Career averaged effort ratio? ~7:1
Best advice on non-majors teaching?

• Avoid it
  – At least for first couple years of a faculty appointment

• If you can't avoid it, plan defensively
  – Realistically assess effort required
  – Balance effort in classroom teaching against other responsibilities

• Consider team teaching