

*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.

### Table of Contents

- I. [Introduction](#)
- II. [The Astronomy Nonmajors Curriculum](#)
- III. [Elements of Teaching](#)
- IV. [Goals](#)
- V. [Content and Texts](#)
- VI. [Effort](#)
- VII. [The Teaching/Research Balance](#)
- VIII. [Special Effort Required in Nonmajors Teaching](#)
- IX. [General Tips](#)
- X. [Your Student Target Audience](#)
- XI. [Interactions with Students](#)
- 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





**KEEP  
CALM  
AND  
CHECK  
THE FACTS**

# THE FACTS

#1: There is no agreement on what constitutes good teaching

- ... on what students ought to learn
- ... on how well they ought to learn it
- ... on how to deliver good teaching
- ... on how to evaluate good teaching

## #2: Astronomy departments are ~unique among disciplines in the fraction of effort devoted to elementary non-majors courses.

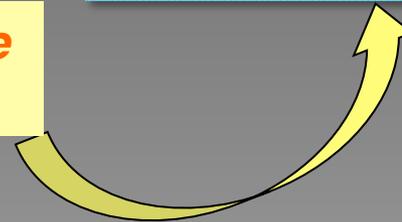
- Majors represent  $\leq \sim 3\%$  of typical astronomy department enrollments
- Your salary depends on large non-majors enrollment
- Most of your teaching effort will not be directed at training or recruiting future scientists

# #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<sup>th</sup> percentile in math/science aptitude.
- Huge disconnect between content and audience

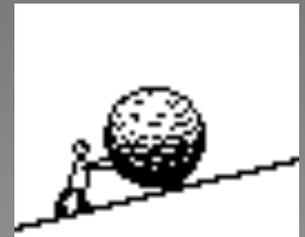


*Tyranny of the  
Gaussian Tail*



# *The Central Conundrum*

*You are being asked to teach a highly technical subject to a mass undergraduate audience that has been selected to lack the background and motivation needed to understand its technical aspects(!)*



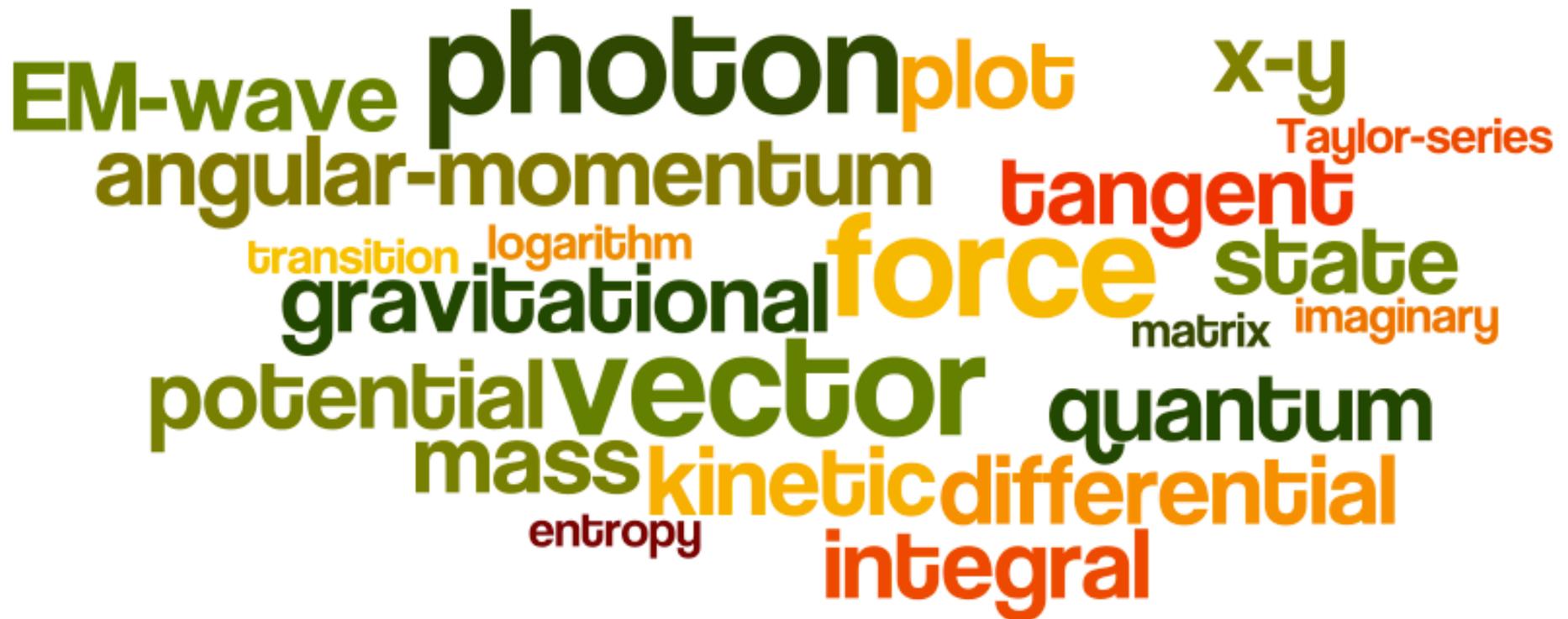
#3a: Key Corollary. To communicate, you will have to retrain your brain and learn to translate the way you think into a ninth-grade conceptual universe.



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.

Grad student conceptual universe



# Other Corollaries

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



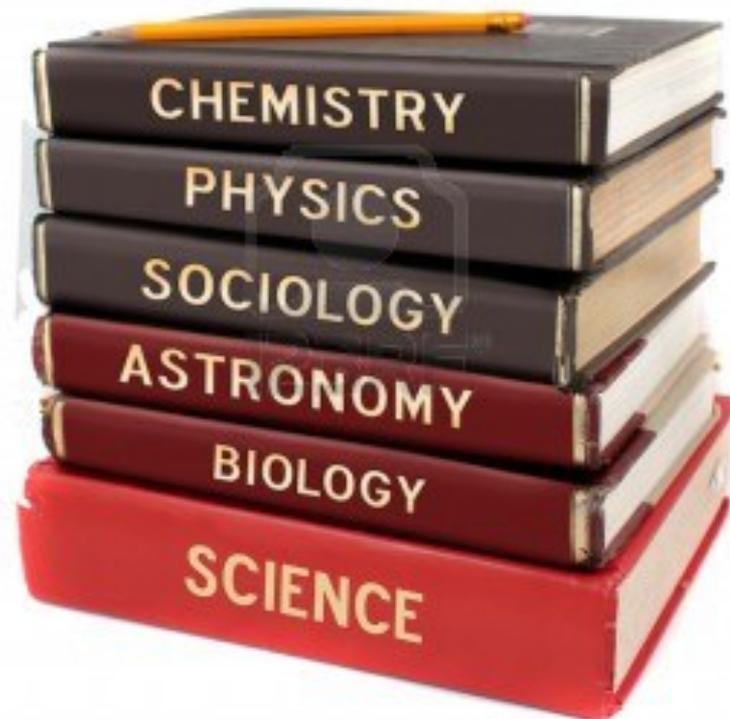
#3c: It is HARDER to teach a course  
WITHOUT mathematics than with it

# #4: Beginning teachers of elementary astronomy courses DON'T KNOW THE SUBJECT!

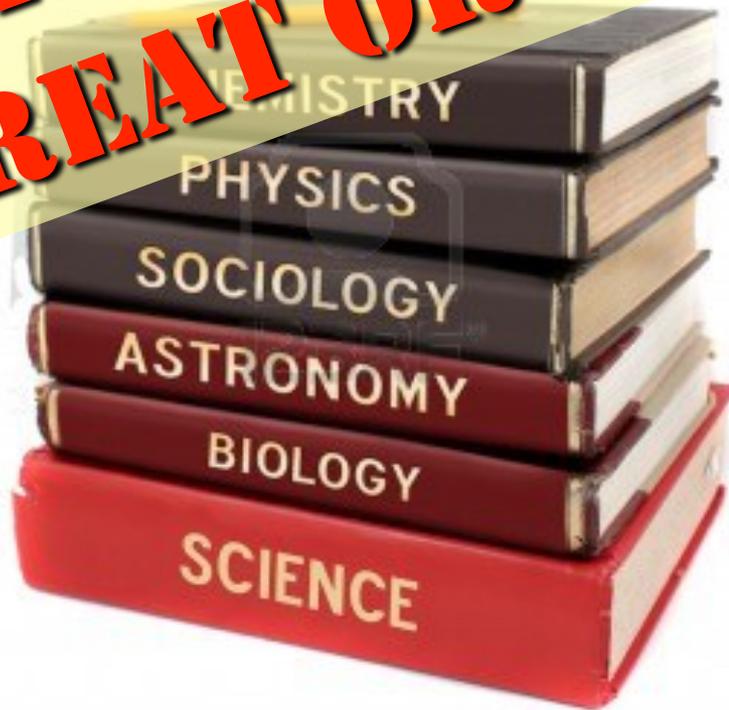
- Elementary courses: broad and shallow
- Professional training: narrow and deep
  - Typically little exposure to areas like history, solar-system astronomy, exobiology, stellar astrophysics (increasingly), etc., which are important in elementary courses.
- Many noble goals of first-time teachers evaporate as this fact sinks in



# Your Friend, the Textbook?



**THE TEXTBOOK:  
THREAT OR MENACE?**



# EXHIBIT A:

■ **Table 3-2** | **Total and Annular Eclipses of the Sun, 2006 to 2016\*\***

Date	Total/Annular (T/A)	Time of Midclipse* (GMT)	Maximum Length of Total or Annular Phase (Min:Sec)	Area of Visibility
2006 Mar. 29	T	10 <sup>h</sup>	4:07	Atlantic, Africa, Turkey
2006 Sept. 22	A	12 <sup>h</sup>	7:09	N.E. of S. America, Atlantic
2008 Feb. 7	A	4 <sup>h</sup>	2:14	S. Pacific, Antarctica
2008 Aug. 1	T	10 <sup>h</sup>	2:28	Canada, Arctic, Siberia
2009 Jan. 26	A	8 <sup>h</sup>	7:56	S. Atlantic, Indian Ocean
2009 July 22	T	3 <sup>h</sup>	6:40	Asia, Pacific
2010 Jan. 15	A	7 <sup>h</sup>	11:10	Africa, Indian Ocean
2010 July 11	T	20 <sup>h</sup>	5:20	Pacific, S. America
2012 May 20	A	23 <sup>h</sup>	5:46	Japan, N. Pacific, W. U.S.
2012 Nov. 13	T	22 <sup>h</sup>	4:02	Australia, S. Pacific
2013 May 10	A	0 <sup>h</sup>	6:04	Australia, Pacific
2013 Nov. 3	AT	13 <sup>h</sup>	1:40	Atlantic, Africa
2015 March 20	T	10 <sup>h</sup>	2:47	N. Atlantic, Arctic
2016 March 9	T	2 <sup>h</sup>	4:10	Borneo, Pacific
2016 Sept. 1	A	9 <sup>h</sup>	3:06	Atlantic, Africa, Indian Oc.

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.

<sup>h</sup>hours.

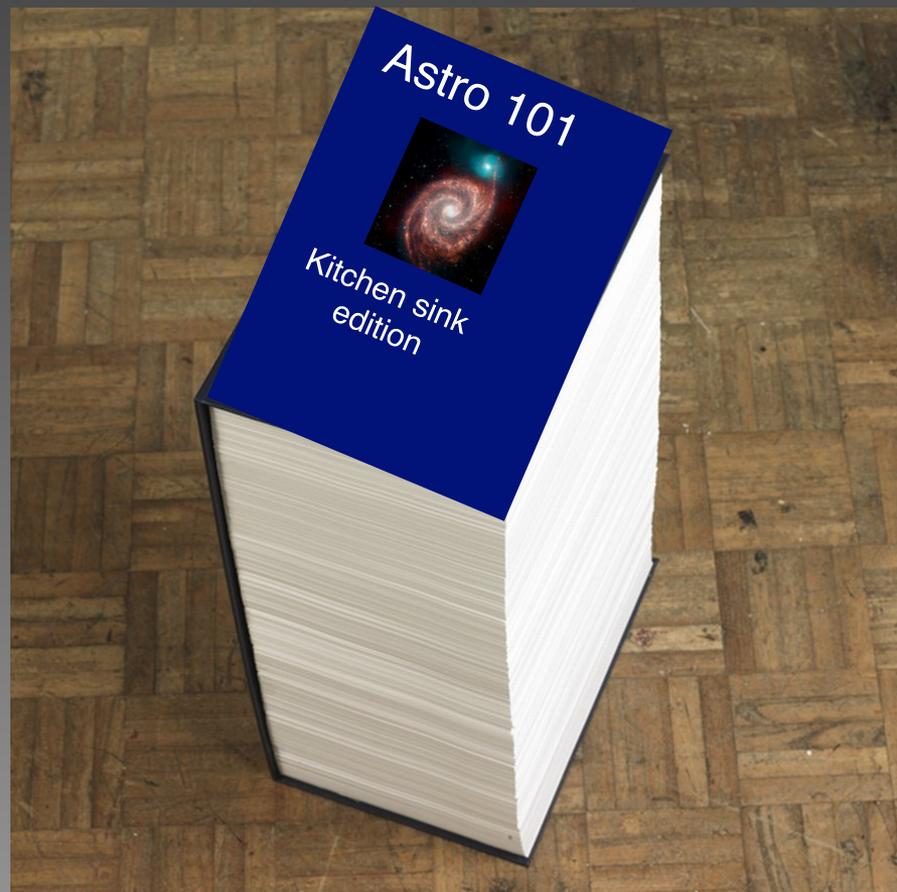
\*\*There are no total or annular eclipses of the sun during 2014.

## #5: THE TEXTBOOK: THREAT OR MENACE?

- Beautiful but flawed; students never like them
- Not enough information for you; too much for students
- 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

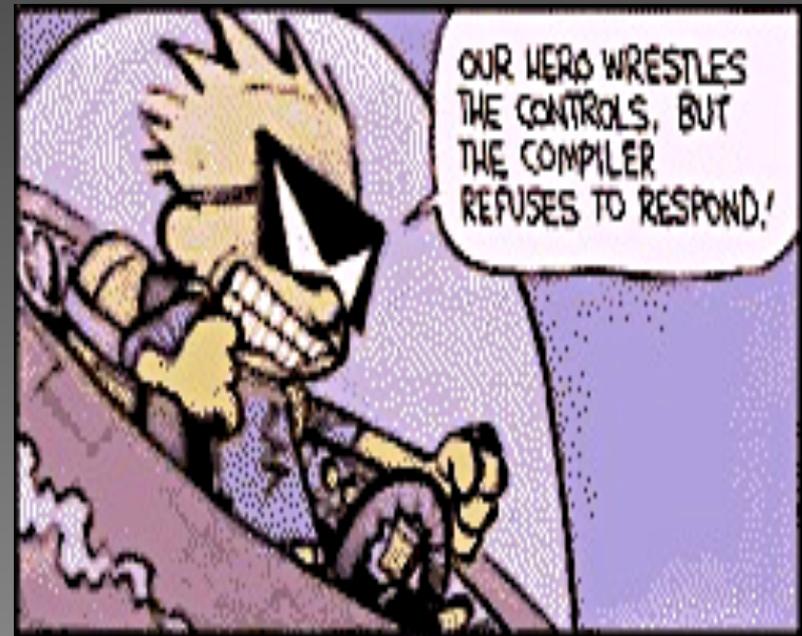
## #5: THE TEXTBOOK: THREAT OR MENACE?

- So: you have to read the damn thing



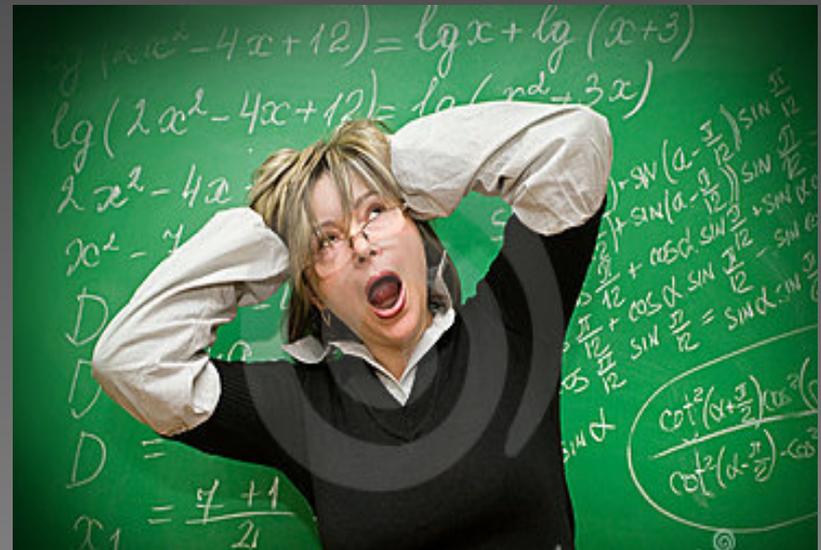
# #6: Evangelical emphasis on electronics in teaching imposes a high cost/benefit ratio

- 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



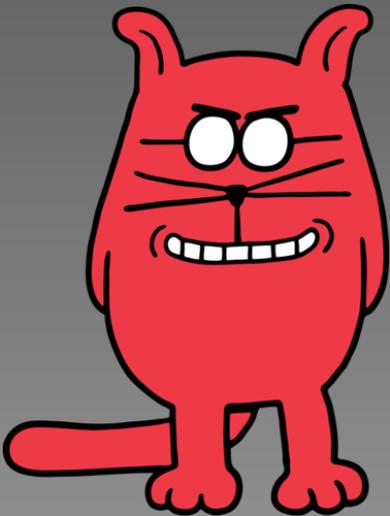
# #6: Evangelical emphasis on electronics in teaching imposes a high cost/benefit ratio

- Professors are now expected to undertake roles in electronic media previously assumed by publishing companies and movie studios.





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 semi-autonomous operation; 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. A GOOD thing.
- Lower cost for students (30%?). A GOOD thing.

- Cons

- NO HELP FOR YOU! 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, where people are fungible)

# Implication?

- 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 good 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% \*
- My advice: aim for the top 60%; you will have difficulty reaching the bottom 25%.

\* Always determine the assumptions being made by reform advocates about the target audience.

# THE ESSENTIAL FACT

#9: Good teaching takes much more effort than you expect



# THE ESSENTIAL FACT

#9: 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

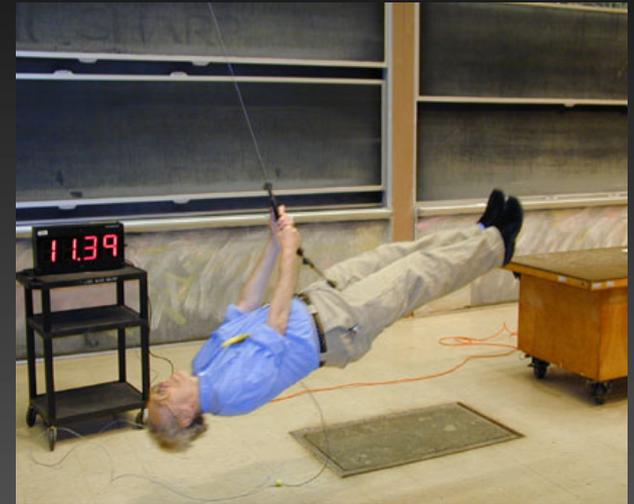
- Student/Faculty ratio?
  - S/F ~ 12-30 in public universities.
  - Hey, not too bad!
  - Oops! Forgot conversion from full-time to "3-hour" students per semester. That's 1:5, so....
  - Effective S/F ~ 60-150 each semester.
  - That's 2-5 courses per semester @ 30 stu/course  
OR 1 course @ 60-150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

## Portent #2



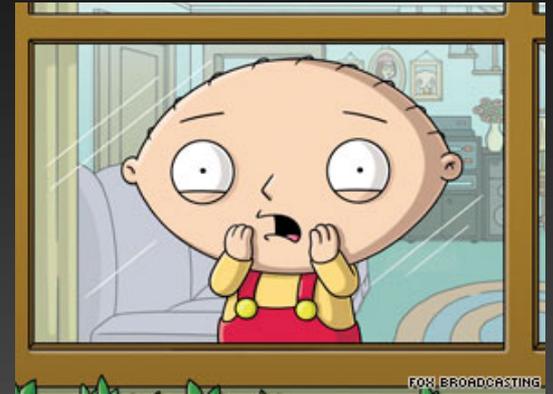
- The Churchillian standard
  - It took Winston Churchill 8 hours to prepare a 40-minute speech.
  - A 12:1 ratio of preparation to delivery effort
  - Churchill had 2-3 paid research assistants.
  - He was smarter than most college professors.

# 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". 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



**INDESCRIBABLE...  
INDESTRUCTIBLE!  
NOTHING CAN STOP IT!**

# THE MOOC



**ONE HOUR OF COURSE VIDEO  
REQUIRES 50-100 HOURS  
OF PREPARATION**

**- SEBASTIAN THRUN** UDACITY COURSE EDx

PRODUCED BY **STEPHEN DOWNES** DIRECTED BY **GEORGE SIEMENS** SCREENPLAY BY **DAVE CORMIER**

BY RYNE H. MULLIGATE A TOKYNN PRODUCTION - COLOR BY DE LUXE **ALEC COUGOS**

**Portent #6**

# Portent #7

- "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 #8

- Your students have no inherent interest in or motivation for learning the subject
- Unlike majors courses, you must make special efforts in "*engagement*"
- The popular solution?



# SHOW BIZ

- Brush up your comedy bits, song & dance routines, etc
- *Engagement* implies theatrics – dig deep!



# #9a: 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 )
- $N_{\text{stu}}/50$  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: TOTAL/IN-CLASS = 5:1**

# #9b: Implications

- Great 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).
- 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.
- > 500 hours of effort to develop a "mature" course
- Career averaged effort ratio: ~7:1

# Best Advice on Non-Majors Teaching?

**PLAN DEFENSIVELY**

# Best Advice on Non-Majors Teaching?

- Get experience in grad school (e.g. summer teaching)
- Have clearly defined goals
  - ... that realistically match target audience and available resources
- Explicitly consider grading effort
- Deliberately "underschedule"
- Design to avoid the "Tyranny of the Gaussian Tail"
- Quantitative reasoning/critical thinking? Use caution!
  - Best approach: term papers on allied topics
- Design for a 5 year period
  - You cannot afford to make major revisions on a shorter timescale
  - You will quickly become unreceptive to the endless stream of teaching reform movements
- Consider team teaching

# The End

