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

* R. W. O'Connell, AER, Issue 1, Volume 6, 2007

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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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Abstract

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"SPREZZATURA"

Def: the art of concealing skillful effort behind seeming nonchalance

Quantifying "Sprezzatura":

"Effort Multiplier"

The total amount of professor effort needed to deliver one hour of classroom teaching

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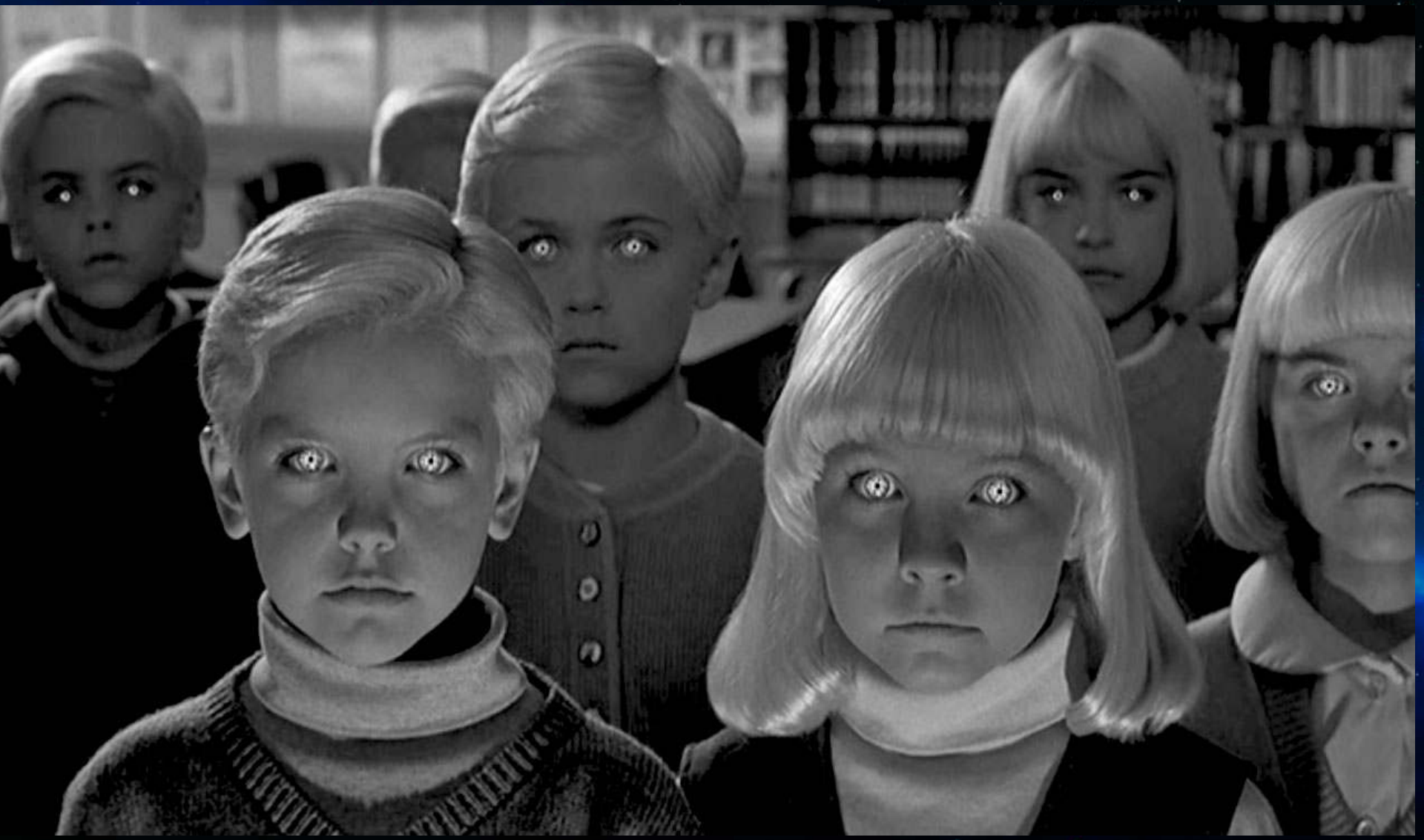
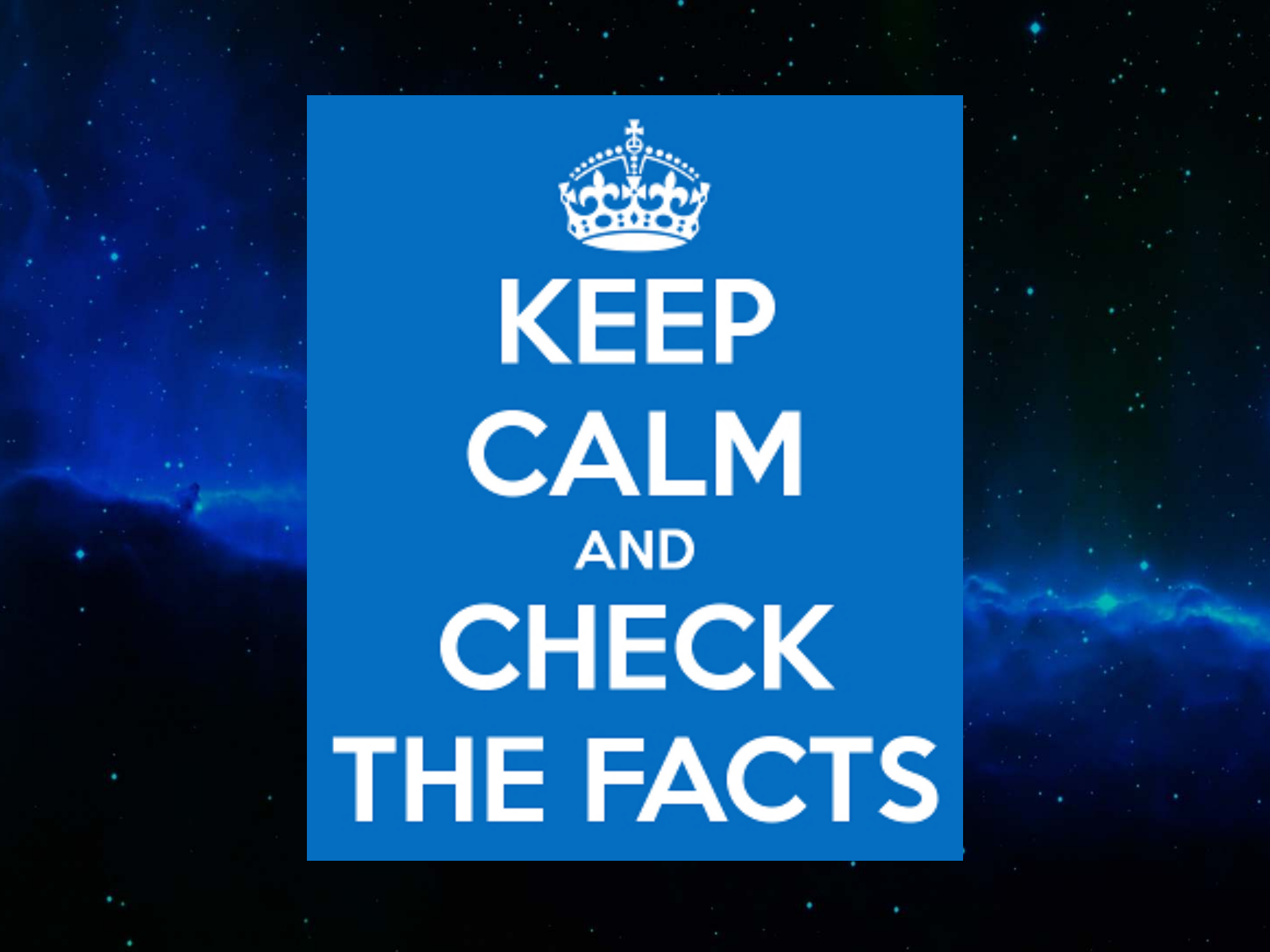
5 - 15 hours



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

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DON'T WORRY TOO MUCH ABOUT "EXPERT" OPINION

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

- Majors represent <~ 3% of typical astronomy department enrollments
- Your salary depends on large non-majors enrollment
- Sadly, most of your teaching effort will not be directed at training or recruiting future scientists

#3: Astronomy non-majors courses are intended to be taught at very low per-capita costs

- Large class sizes: ~50-500
- Staff Support: In-class TA's? discussion TA's? graders? tech staff for demos, labs, web, A/V? etc.

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- Large class sizes: ~50-500
- Staff Support: In-class TA's? discussion TA's? graders? tech support for demos, labs, web, A/V? etc.
- Goals for your course must be realistic in the context of resources offered.

MOSTLY MISSING

#4: Your students will be the least prepared of any in your university for your courses

- Effectively by definition, they will be below the 50th 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(!)

#4a: Key Corollary. To communicate, you will have to retrain your brain and learn to translate the way you think into a tenth-grade conceptual universe.

Get yourself a new brain

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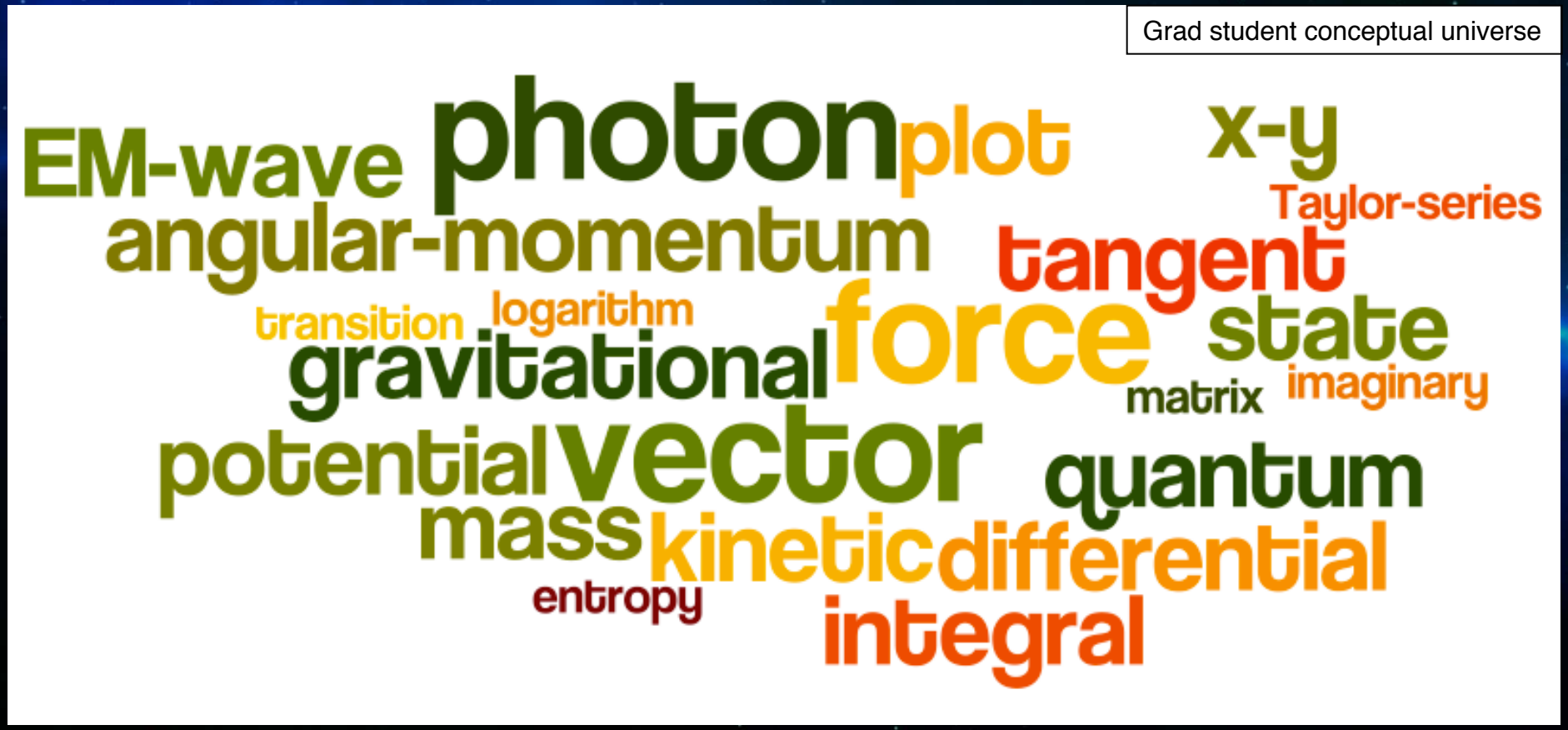


#4a: Key Corollary. To communicate, you will have to retrain your brain and learn to translate the way you think into a tenth-grade conceptual universe.

Counterintuitive Corollaries

#4b: It is HARDER to teach an ELEMENTARY course than a graduate course

#4c: It is HARDER to teach a course WITHOUT MATHEMATICS than with it

→ The reverse of what outsiders naively assume

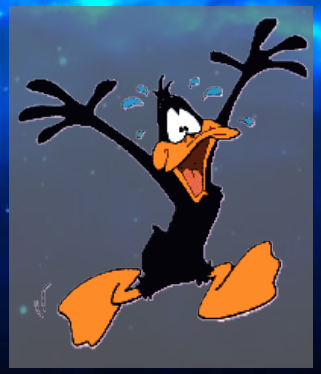

Developing and delivering
course content is your
overriding responsibility.
BUT...

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

- A scandal?
- No! A product of graduate training.
- Elementary courses: broad and shallow
- Graduate training: narrow and deep
  - Missing: *history, constellations, eclipses, tides, meteors, solar physics, space program, binary stars, planets OR galaxies, exobiology, SETI, cosmology, etc.*

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

- You face a steep learning curve
- Many noble goals of first-time teachers evaporate as this fact sinks in



Your Friend, the Textbook?

THE TEXTBOOK: THREAT OR MENACE?

#6: 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

EXHIBIT A:

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

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

hhours.

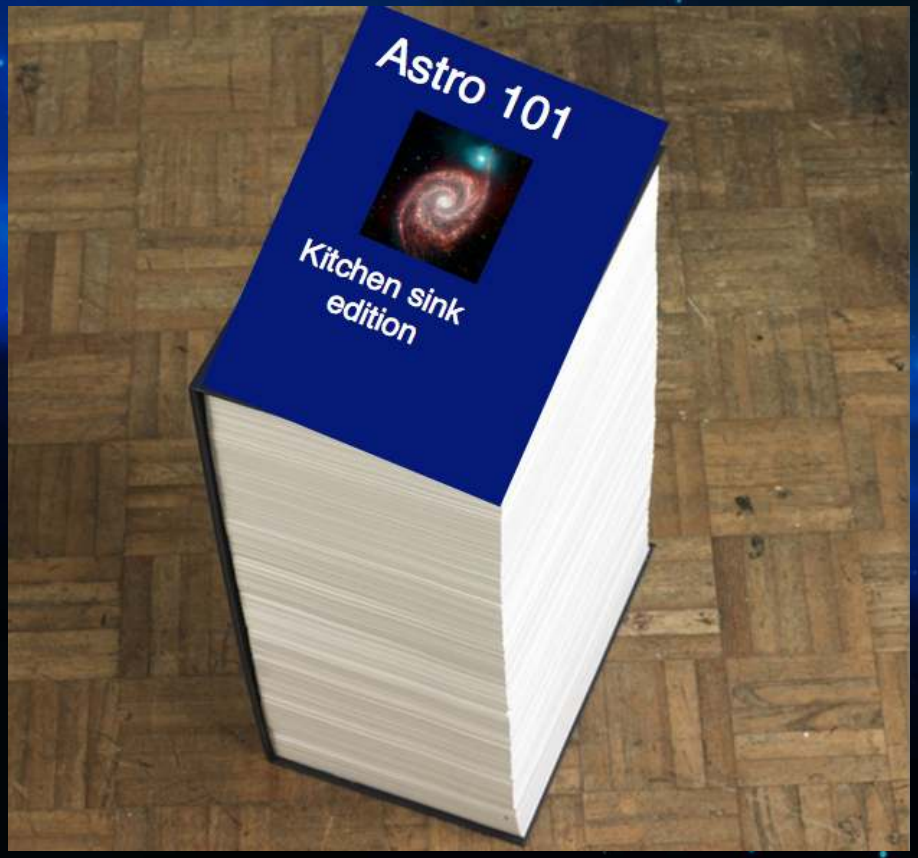
**There are no total or annular eclipses of the sun during 2014.

#6: 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

#6: THE TEXTBOOK: THREAT OR MENACE?

- So: you have to read the damn thing



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

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- Complex; long learning curve; very time-consuming (can you say “PowerPoint”?)
- Effort is added to that needed in pre-electronic teaching
- Perpetual revisions needed because of commercial/ institutional imperative for "improvement"

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"cost" = faculty time

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#7: 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

#8: There is ~no academic "middle management"

- Academic programs are self-administered by the faculty.
- Example: UVa Arts & Sciences
  - 1100 instructors & staff
  - $230M annual budget
  - 5,000,000 student-hours of instruction per year
  - 25 FTE academic managers (mostly 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, rigidity, 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.

#9: Your first defining decision is your "*target audience*"

- *Target audience*: the fraction of your class expected to achieve fairly good comprehension of the material
- Non-majors exhibit a huge range in aptitude & motivation
- A course designed for 100% of the class will be very different from one designed for the best 50%
  - What score distribution do you expect on a 100-point exam?
- My advice: DESIGN FOR THE TOP 60%; use out-of-class resources to help the bottom 40%

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ALWAYS DETERMINE ASSUMPTIONS MADE BY "REFORM" ADVOCATES ABOUT TARGET AUDIENCE

THE ESSENTIAL FACT

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

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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

8 PORTENTS

PORTENT #1

- **Student/Faculty ratio?**
  - **S/F ~ 12-30 in public universities.**
  - **Hey, not too bad!**

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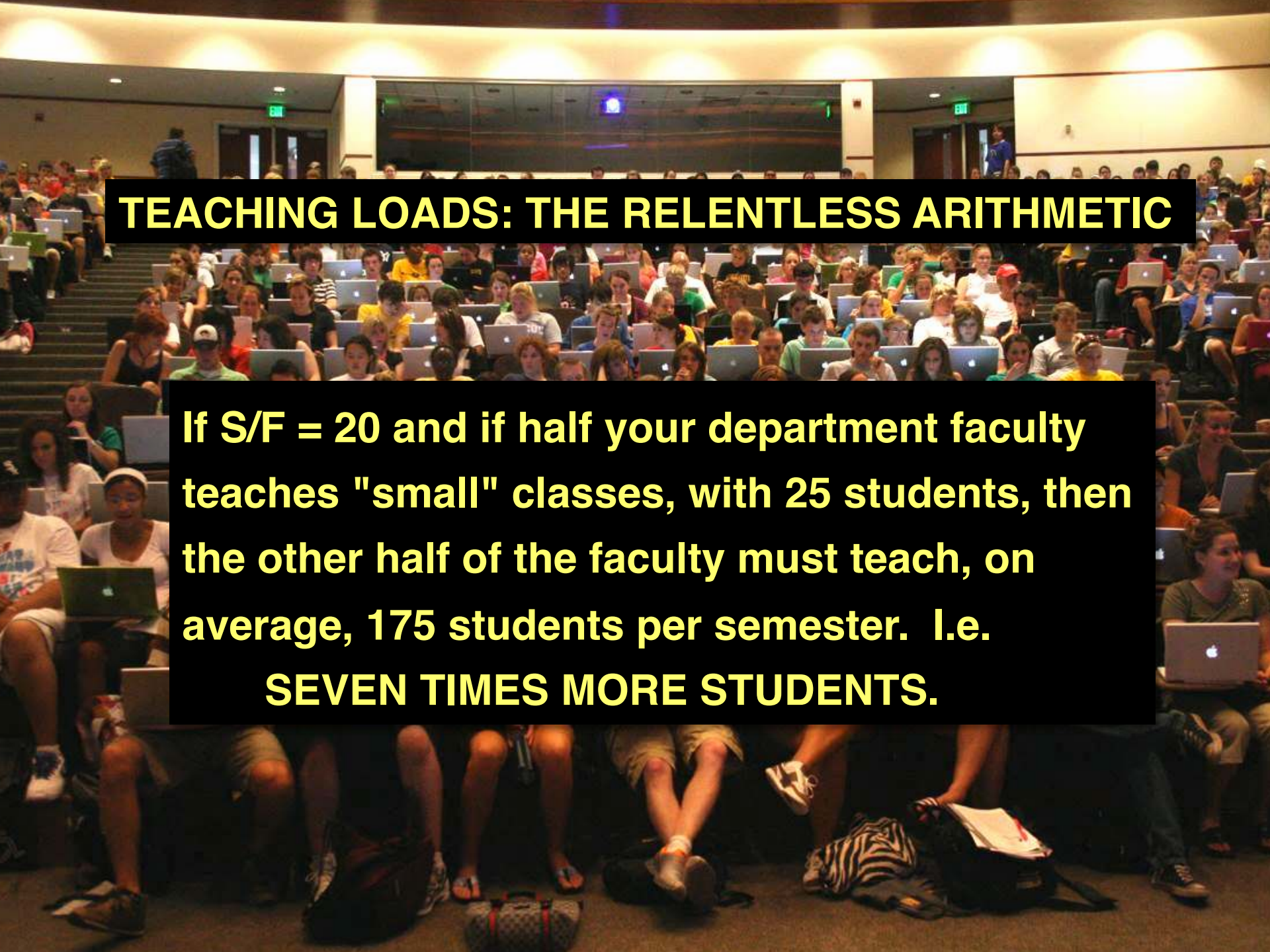
- **Student/Faculty ratio?**
  - S/F ~ 12-30 in public universities.
  - Hey, not too bad!
  - Oops! Forgot that each full-time student takes 5 "3-hour" courses per semester, so...
  - Effective S/F ~ 60-150 each semester.
  - That's 2-5 courses per semester @ 30 stu/course OR 1 course @ 60-150 stu per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



TEACHING LOADS: THE RELENTLESS ARITHMETIC

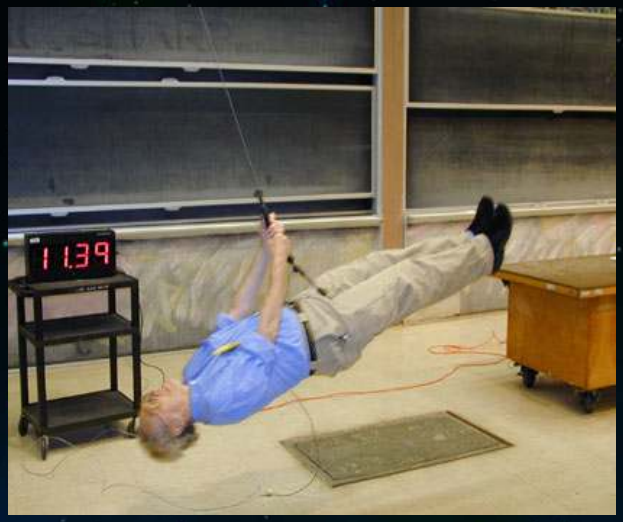
If S/F = 20 and if half your department faculty teaches "small" classes, with 25 students, then the other half of the faculty must teach, on average, 175 students per semester. I.e.

SEVEN TIMES MORE STUDENTS.

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

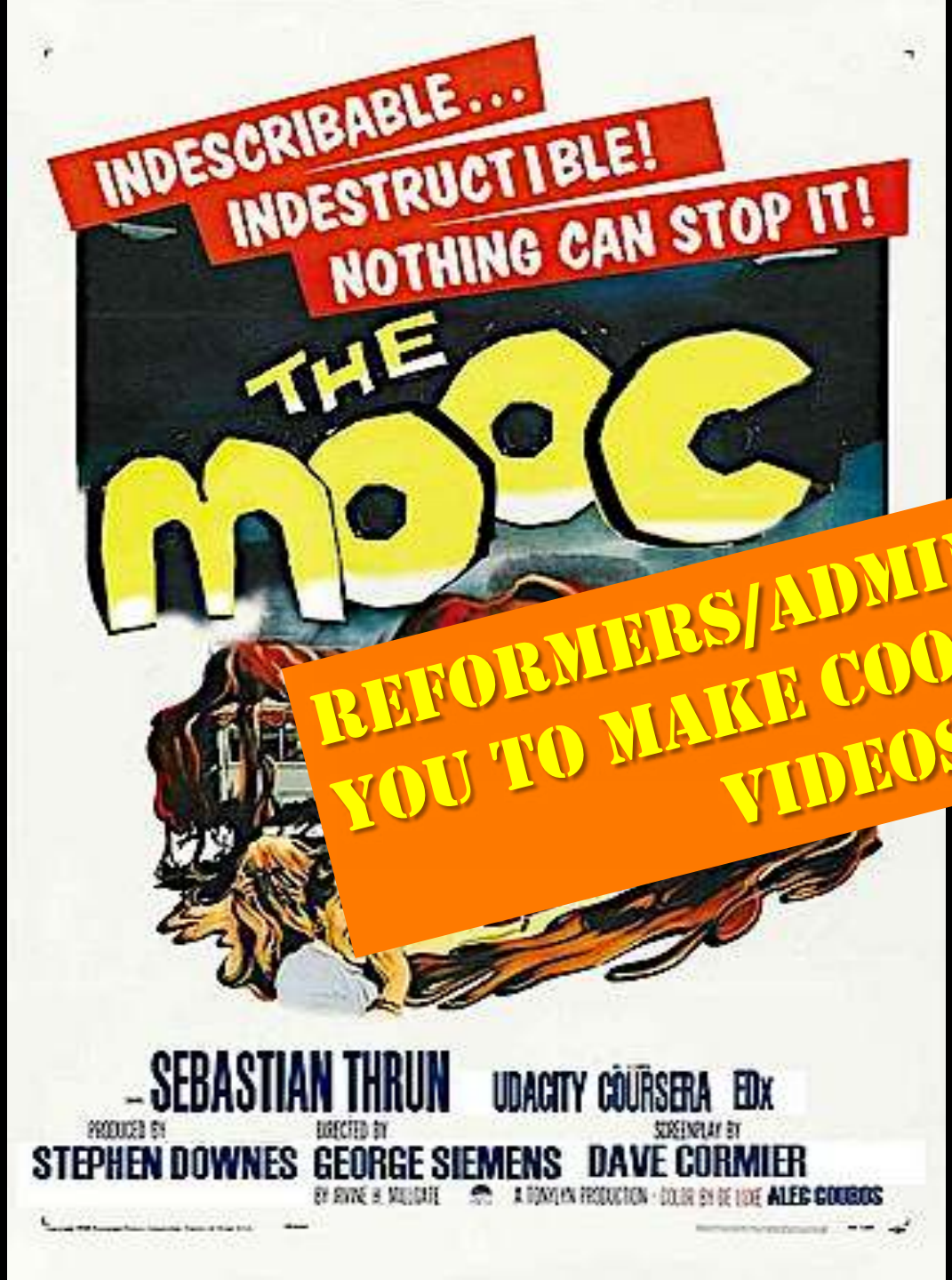
PORTENT #4

- 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

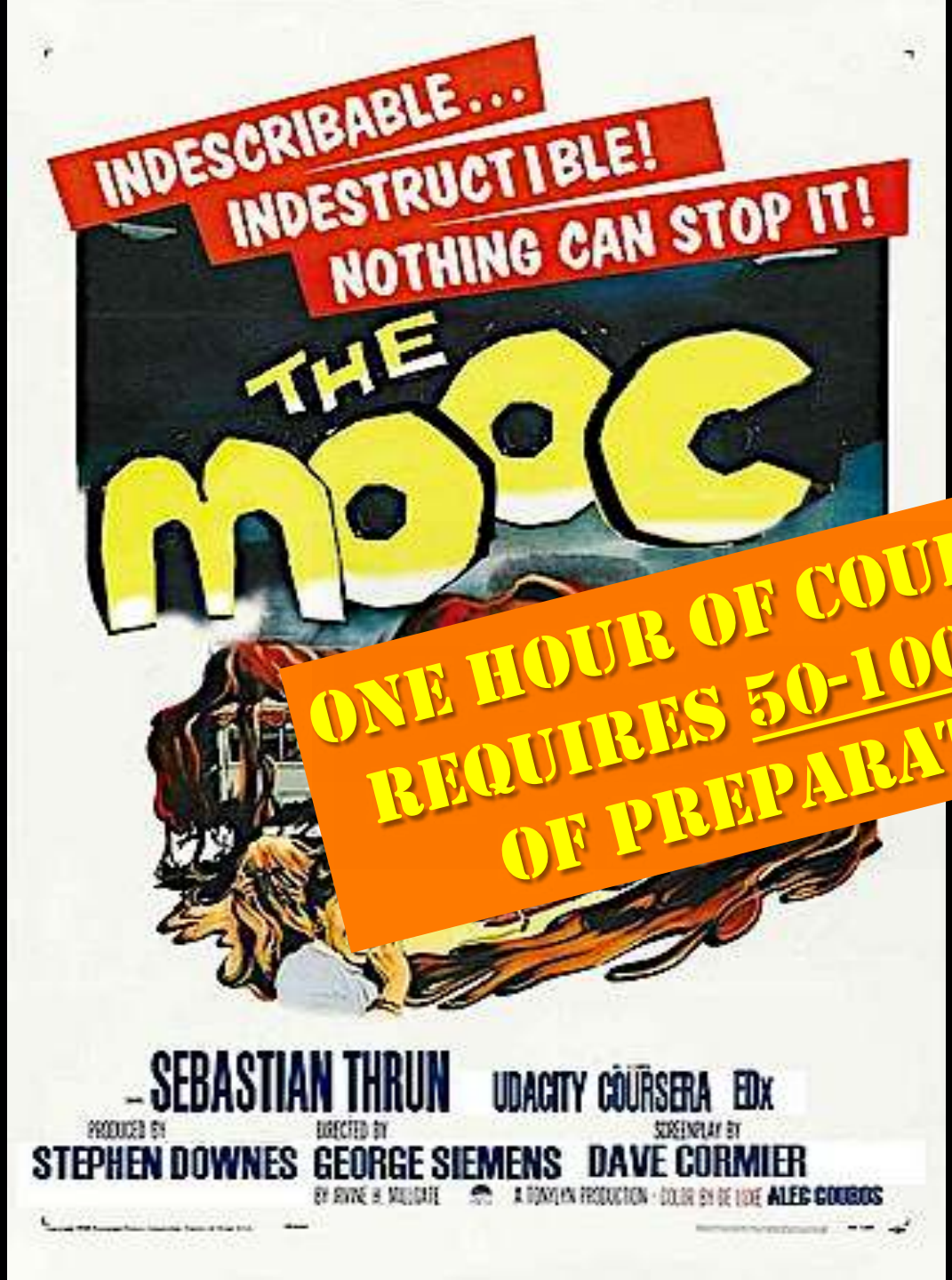
- 50-min lecture ~ 5000 words
  = a "term paper"
- 1 month of class = 12 term papers

PORTENT #6



REFORMERS/ADMINS WANT YOU TO MAKE COOL COURSE VIDEOS

PORTENT #6



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

PORTENT #7: "TYRANNY OF THE ROUTINE"

- **Walking to class & setting up?**
  - 20 min? → One semester's round trips: 28 hours or 5% of your time, simply in transit
- **Grading? Beware!**
  - 5 min x 3 exams x 150 students → 38 hours
  - Objective vs essay/problem exams: 10:1 advantage
  - Add: recording grades, administering software...
- **Time-consuming routine tasks must be factored in to course design**

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! And add more prep time.

Weekly Effort Estimate for a Mature "3 Hour" Non-Majors Course

- 3 hours in class
- 6 hours meeting prep (notes, A/V, demos, in-class exercises) & rehearsal (omits ~2 hours transit time)
- 3 hours course infrastructure (online material; text reading & topic research; syllabus; reading assignments; designing homework, labs, projects, & activities; exam prep; data management; gradekeeping s/w...)
- N_{stu}/50 hours enrollment-dependent effort (student conferences/communications, grading, TA & support staff management, etc). Assumes objective exams and grader support.

TOTAL (for 150 students): 15 hours per week

Effort Multiplier: TOTAL/IN-CLASS = 5

Implications

- The 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 per week per ("3-hour") course
- Upgrades/revisions (typically @ 5 year intervals; e.g. new text or supplementary materials; A/V upgrades; software upgrades; new course management systems; new labs, assignments or in-class exercises): Add 1-2 hours per class meeting.
- > 500 hours of effort to develop a "mature" course

Career-averaged Effort Multiplier: ~7

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"
- Consider team teaching
- 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

Dealing With Teaching Reform

- If teaching reform worked, there wouldn't be any reformers left.
  - Reforms have not converged in the 60 years since Sputnik.
- All teaching is a compromise. In practice, reform debates are not about ideals but cost:benefit ratios.
- Rarely a helpful suggestion, usually a demand for an overhaul.
- Never about more money or more people to help you teach.
- Always means more effort by teachers.
  - Reformers always undervalue faculty time.
  - "Opportunity cost," "diminishing returns" - not in reformers' vocabularies.
  - Should always ask whether net change in productivity is positive.
- Most current college-level reform movements originated in K-12.
- Judge reforms successful only if they have a strong track record with conscripted, not volunteered, faculty & students.
- Desirability of a particular reform is in inverse proportion to administrative enthusiasm.
  - Prime example: MOOCs - the "neutron bombs" of teaching reform

The End