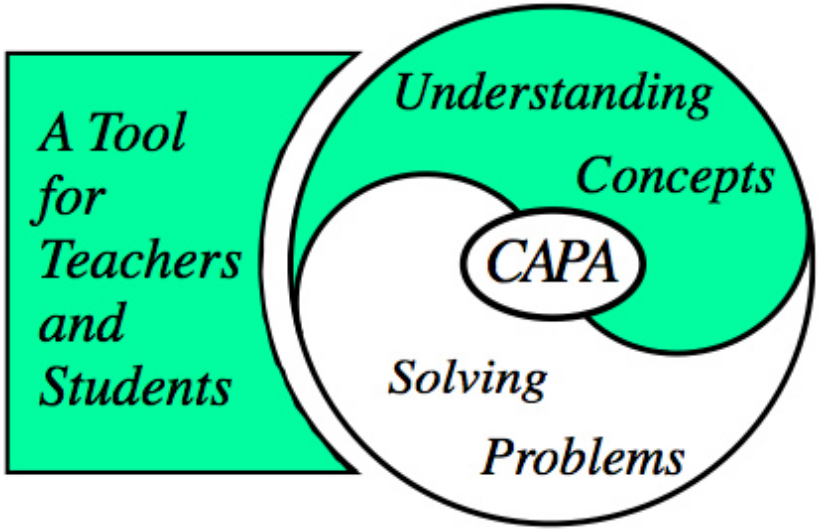
Lessons from (almost) 25 years of hybrid and online physics courses at Michigan State University

Gerd Kortemeyer

Michigan State University

1992 - CAPA

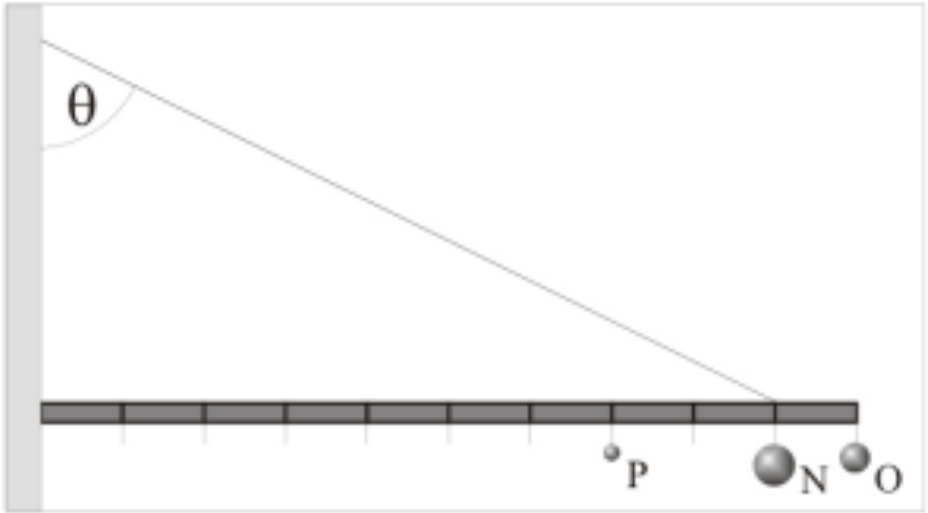
- CAPA – way to offer homework in large enrollment service courses
  - Printed problem sets
  - Entering solutions through Telnet
  - Editing and administration on X-Windows



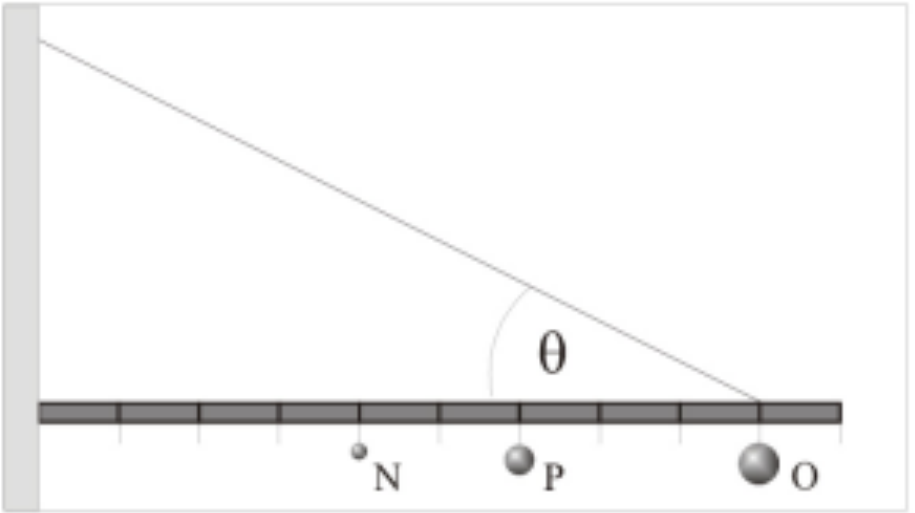
1992 - CAPA

- Different problems for different students

2. [2pt] A 4.30 kg beam has a length 1.30 m and is suspended in a horizontal position as shown. There are 10 equally spaced attachment points, 13.0 cm apart with three masses hanging from the beam. A thin cable attached 13.0 cm from the end makes an angle of 53.0° with the wall as shown.
The masses are N = 8.00 kg, O = 6.00 kg, P = 3.00 kg. Calculate the tension in the cable.



2. [2pt] A 3.90 kg beam has a length 1.20 m and is suspended in a horizontal position as shown. There are 10 equally spaced attachment points, 12.0 cm apart with three masses hanging from the beam. A thin cable attached 12.0 cm from the end makes an angle of 35.0° with the wall as shown.
The masses are N = 4.00 kg, O = 8.00 kg, P = 5.00 kg. Calculate the tension in the cable.

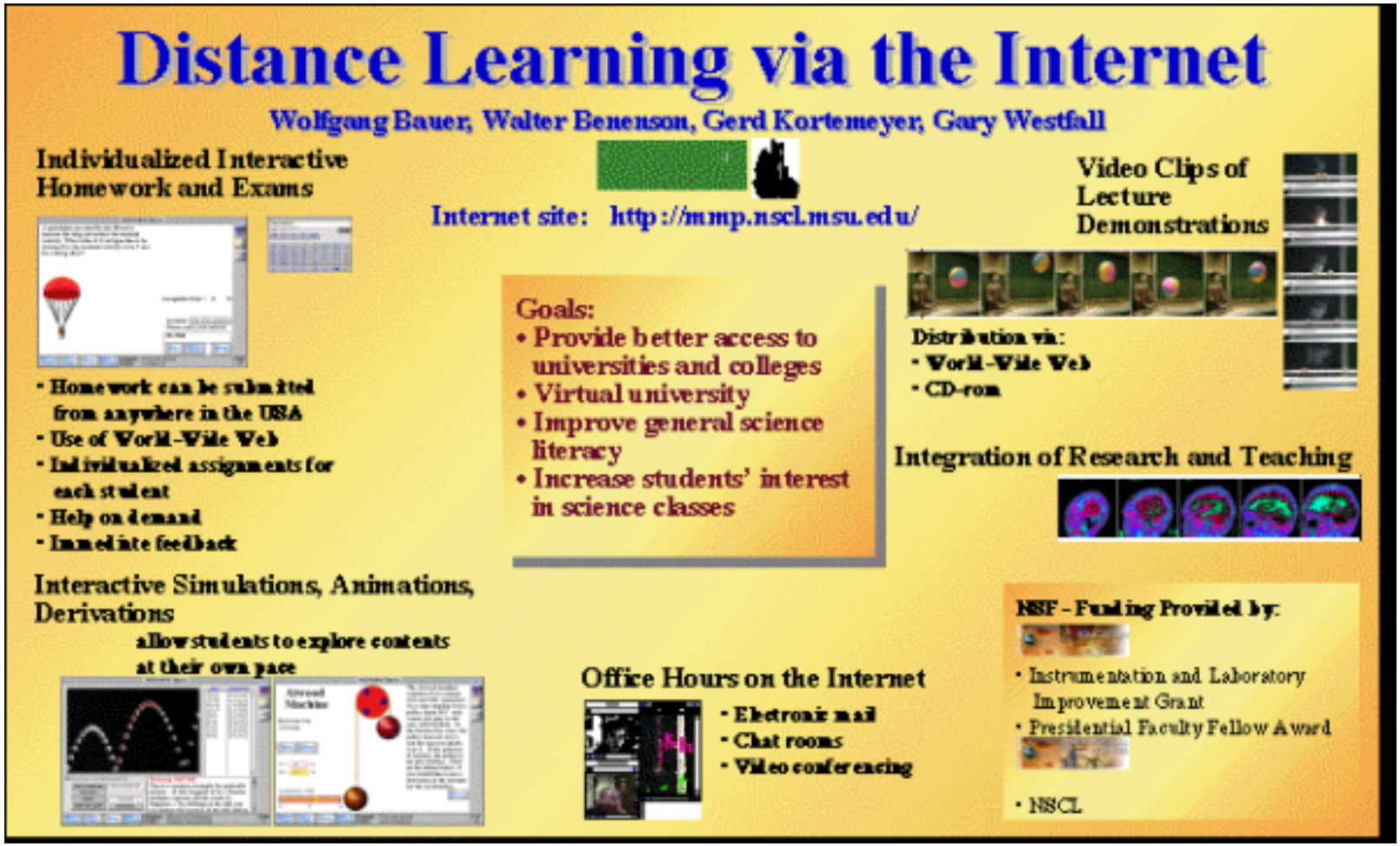


Also 1992 – Hyper-Textbook

- SuperCard
  - Hypertext system, similar to HyperCard
- Distributed on CD-ROM
- All materials for an introductory calculus-based physics course
  - Replaced textbook in traditional courses

1997 – Move to the Web

- Moving SuperCard materials to the web



1997 – Move to the Web

- Delivery platform Lecture*Online*
- Sequencing learning objects
  - Shared within university
- Rudimentary homework system
  - Modeled after CAPA, but completely web-based
- First test course in Fall 1997 with a handful of students

1997 – Move to the Web

Lecture Online

Ch.1 - Units

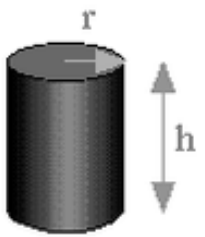
1.11 - H: Volume of Cylinder

EXIT

Homework

This homework is due on Mon Mar 23 23:59:59 1998.

A right cylinder has a radius r of 15.8 cm and a height h of 49.2 cm. What is the volume of the cylinder in m^3?



MSU Lecture Online

You entered 0.01223236.

This is not the correct result.

You might have forgotten the factor π .

Please enter answer here (within 2 percent accuracy):

Submit Result

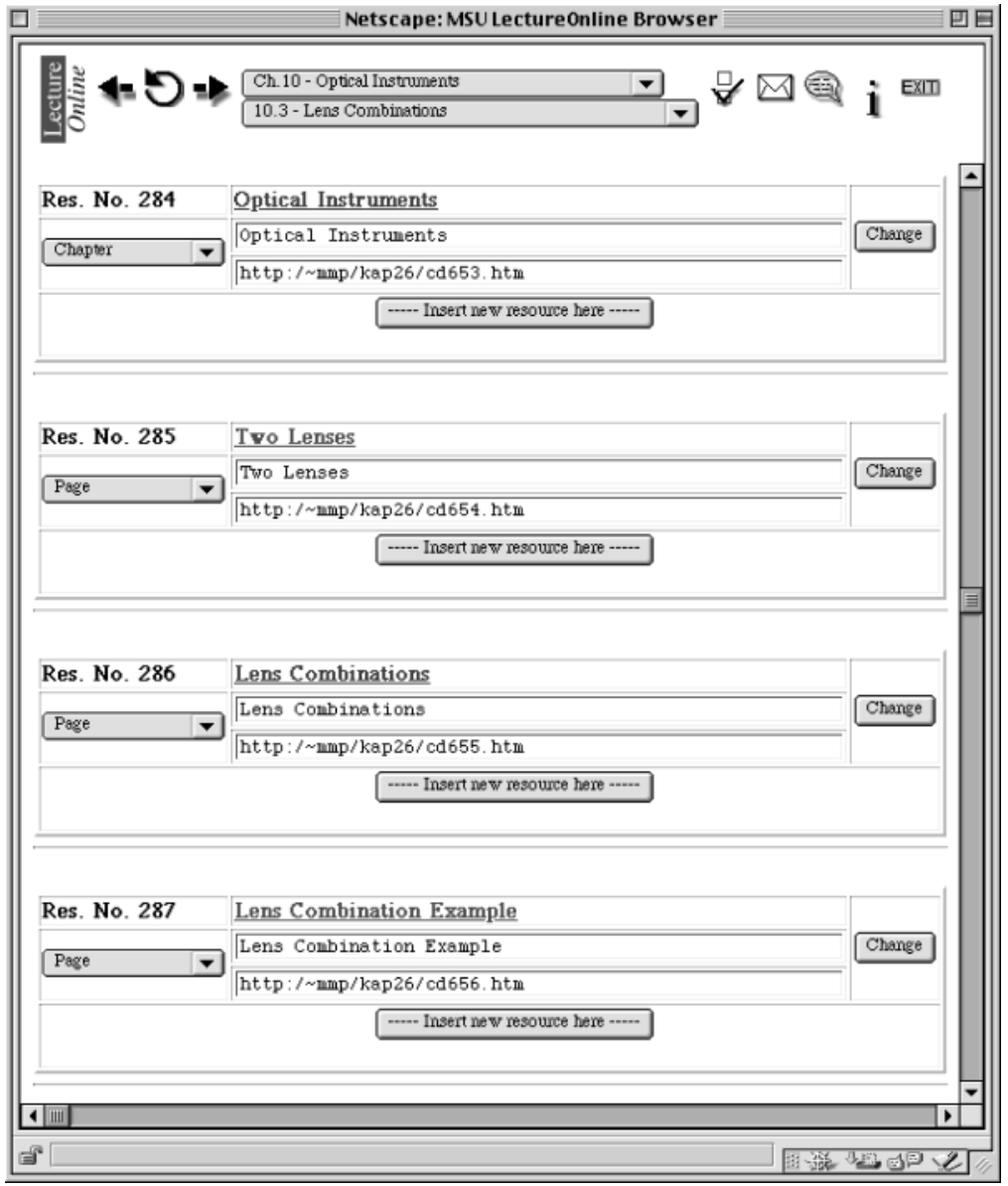
Previous attempts:

Date	Entered value
Wed Mar 18 14:13:48 1998	.01223236

Homework: Volume of Cylinder

1997 – Move to the Web

- Sequencing

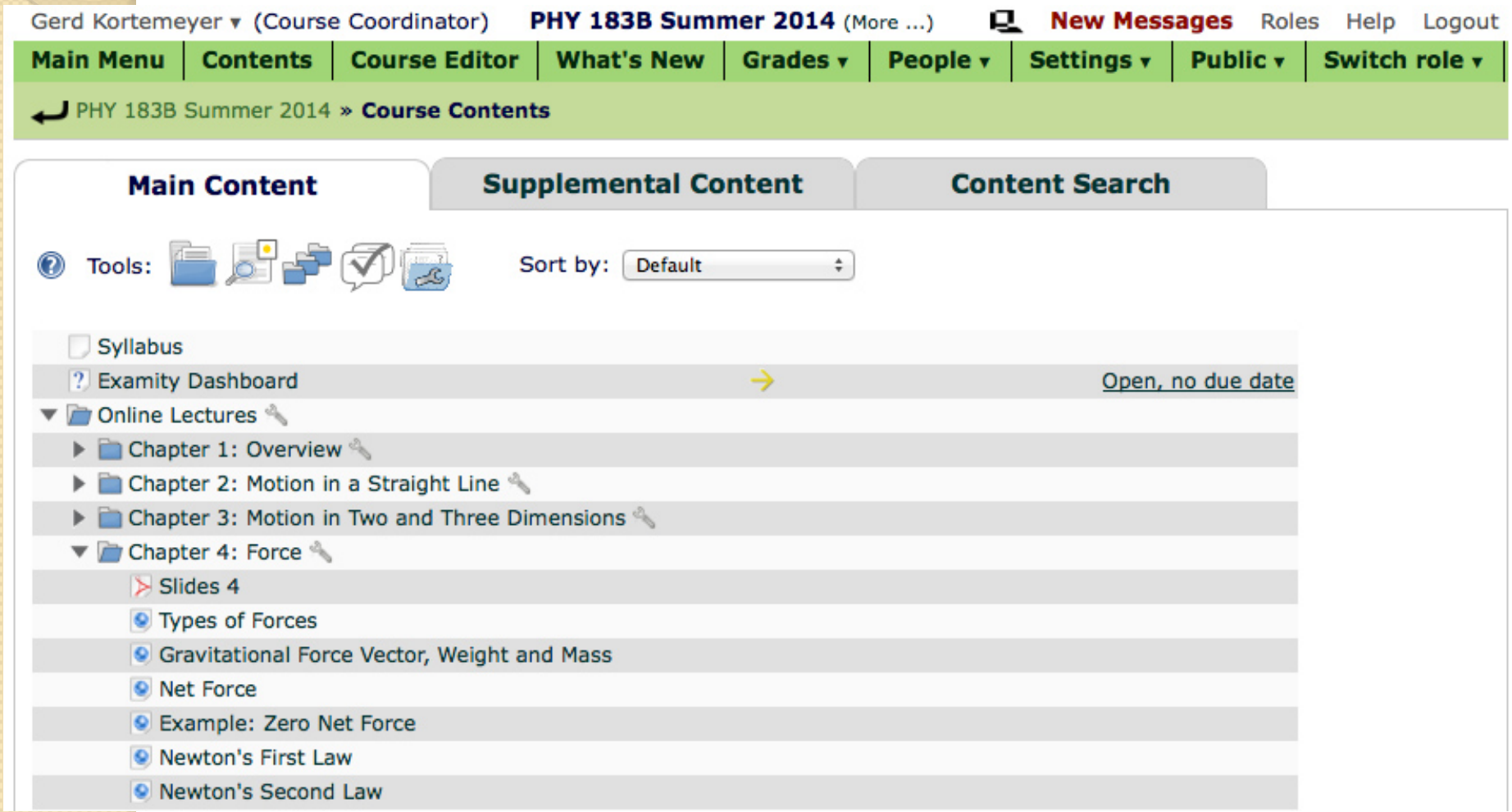


1998 – On the Web

- Started first completely online "Virtual University" course
  - Algebra-based intro physics
- Also offered online components for traditional lectures
  - "Blended"

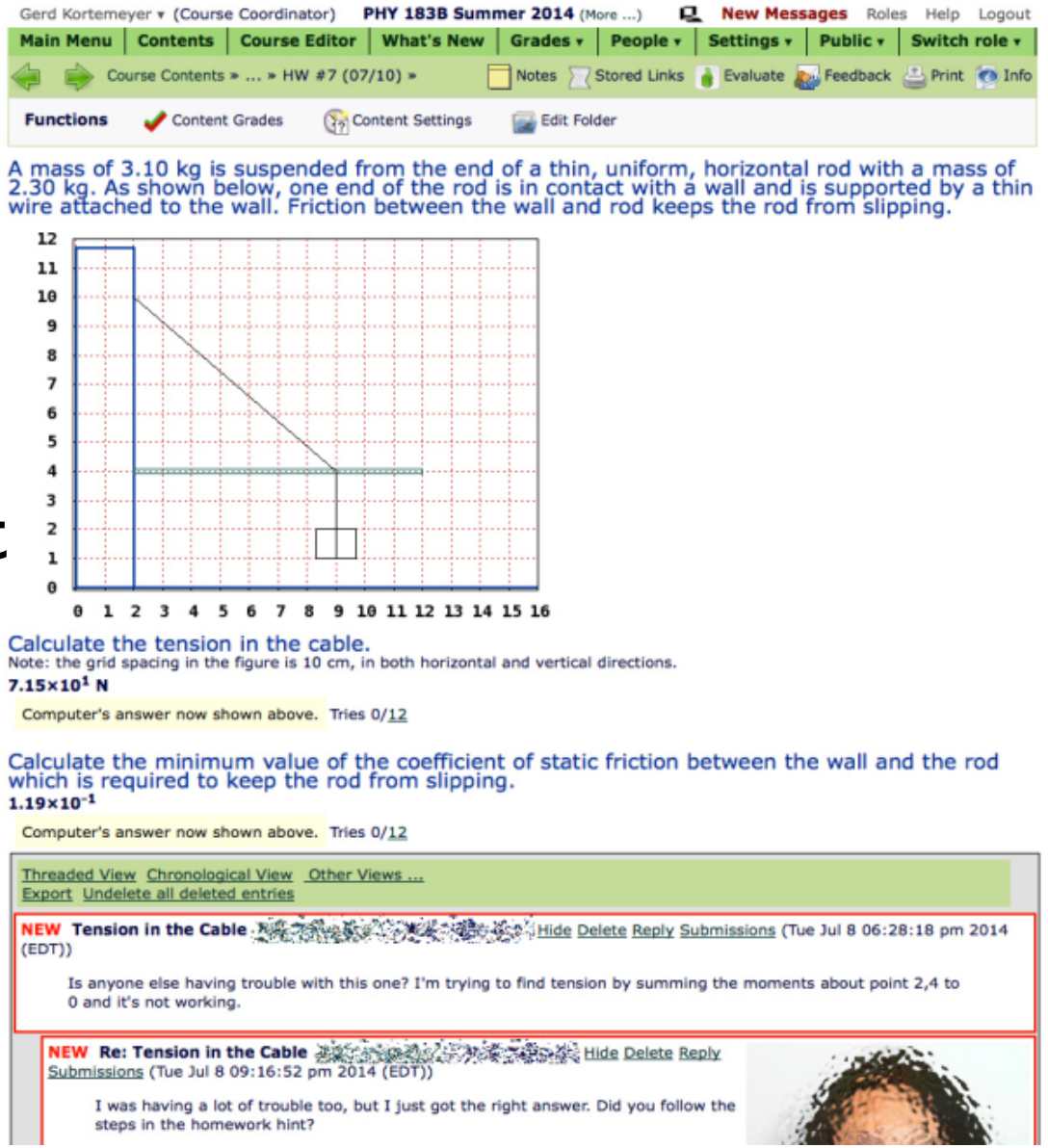
1999 – Started LON-CAPA

- Joined CAPA and Lecture*Online* efforts



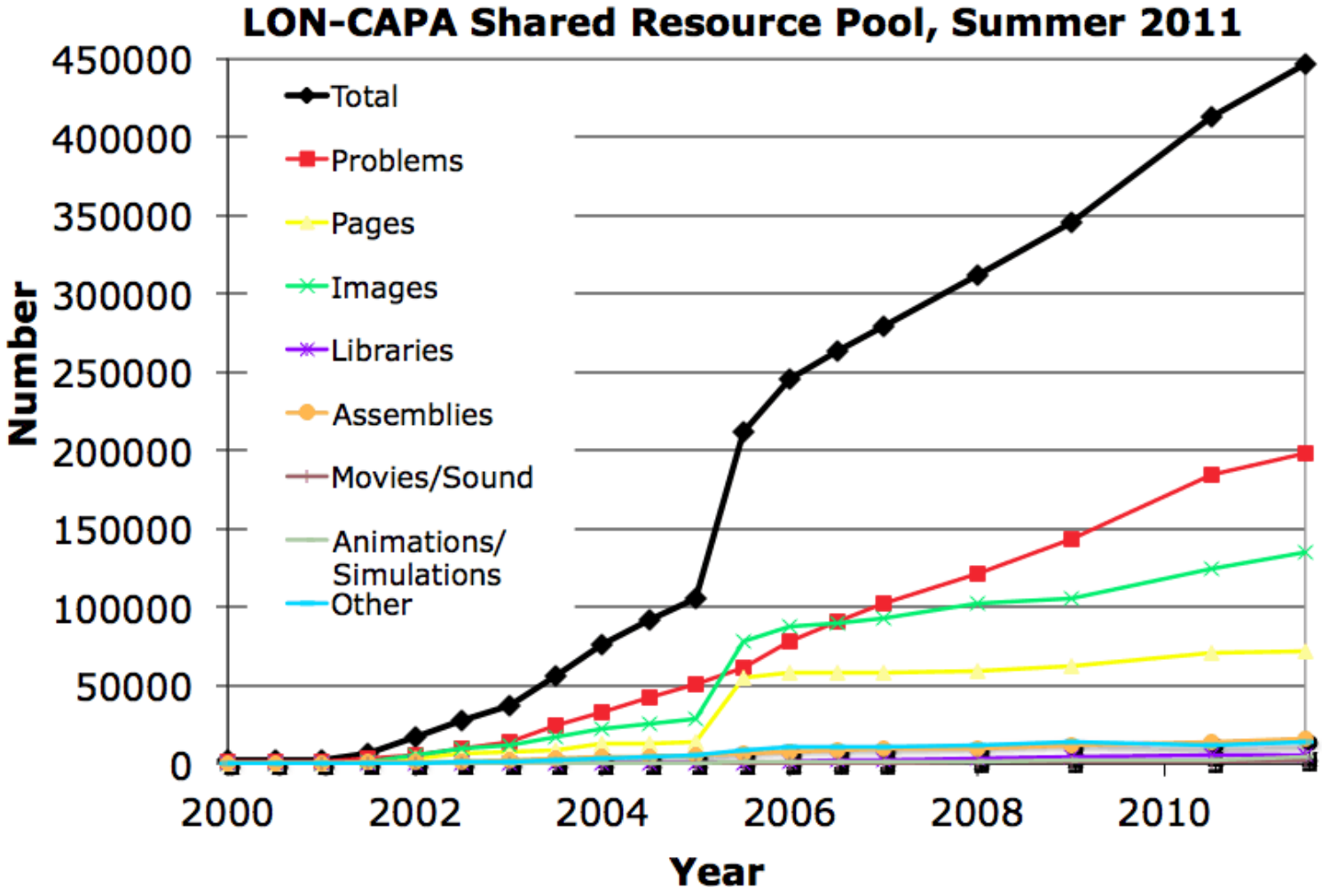
1999 – Started LON-CAPA

- Completely web-based
- Integrated course management
- Open-source, free



1999 – LON-CAPA

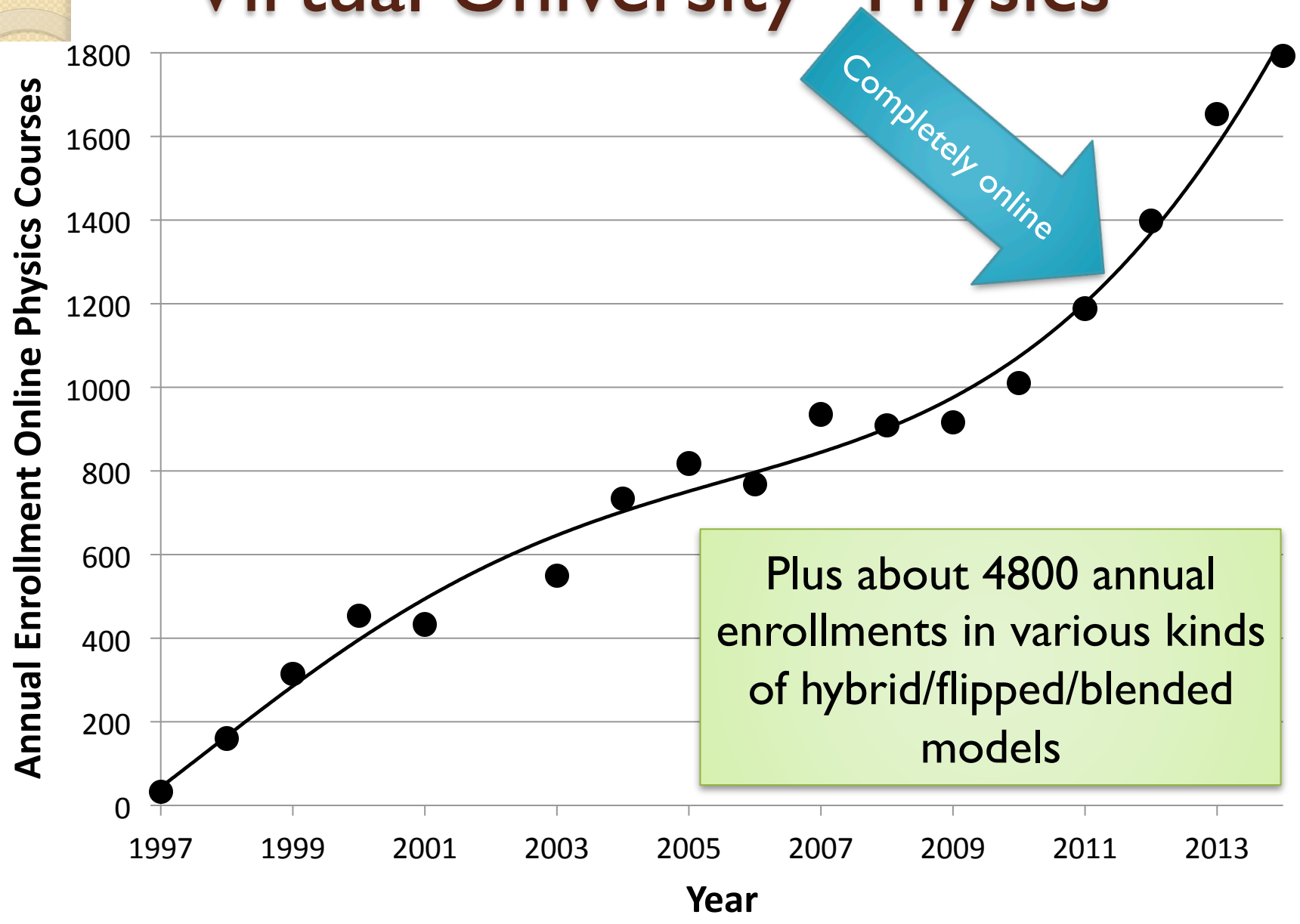
- Content shared across 160 institutions



Since 1999: Virtual University

- In 1999, Virtual Universities were "the future"
- At least initially, most of the students were actually on-campus students
  - Scheduling difficulties
  - Repeating the course
  - Convenience
  - Personal preference
  - …

"Virtual University" Physics



Wide Variety of Course Offerings

- Traditional lecture and textbook
  - Online homework
  - LON-CAPA bubblesheet exams
- Traditional lecture and JiTT
  - Online materials and homework
- Completely online
  - Online materials and homework
  - LON-CAPA bubblesheet or online exams

Wide Variety of Courses

- Flavors
  - Integrative studies
  - Algebra-based
  - Bridge courses
  - Calculus-based, scientists and engineers
  - Calculus-based, life-science (two flavors)
- Timing
  - During semester
  - Over the summer

What have we learned?

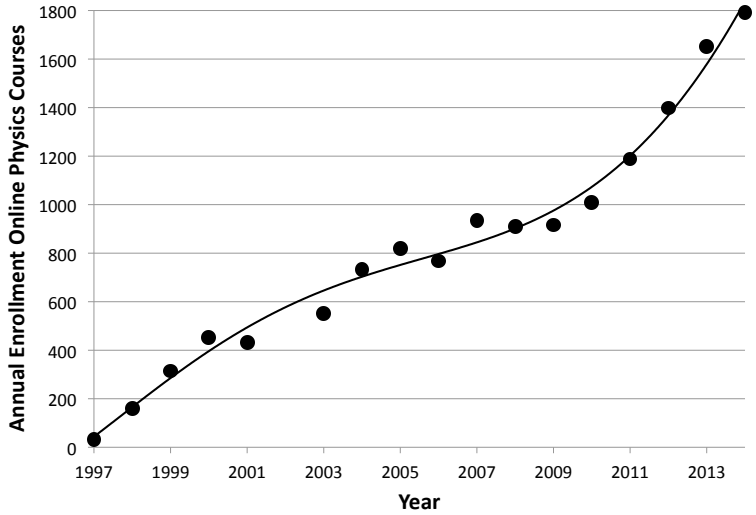
No 1: Re-Usability

- Writing online materials is a lot of work
  - Use the same page or problem across courses and semesters
- Assembling courses is a lot of work
  - Ability to clone courses between semesters
  - Hand-me-downs between faculty
- Backward compatibility
  - What worked once has to keep on working

No 1: Re-Usability

- Even in an optimized environment, maintenance is still an issue
  - Java to HTML5
  - Outdated video codecs
  - Obsolete plugins (Flash, Shockwave, etc.)
  - Accessibility requirements (subtitles, etc.)
  - Mobile device support
- Only the physics in these courses is timeless

No. 2: Growth



- Slow growth is dangerous
  - "Boiling frog" problem, not adjusting personnel
  - There's no space limit, so growth goes unnoticed
  - Overloaded faculty
- And no, online courses are not on autopilot
  - Actually more work, as faculty need to deal with complicated exam logistics
  - Work on online discussions
    - Expectation of 24/7-availability

No. 3: Exams are the bane of online courses

- Students within a certain radius of campus are supposed to take the exams on-campus after-hours
- Need proctors for off-campus students
  - Faculty at other universities
  - Librarians
  - Commanding officers
    - Lots of communication overhead
- New method: online proctoring

No. 3: Exams are the bane of online courses

- Online proctoring

No. 3: Exams are the bane of online courses

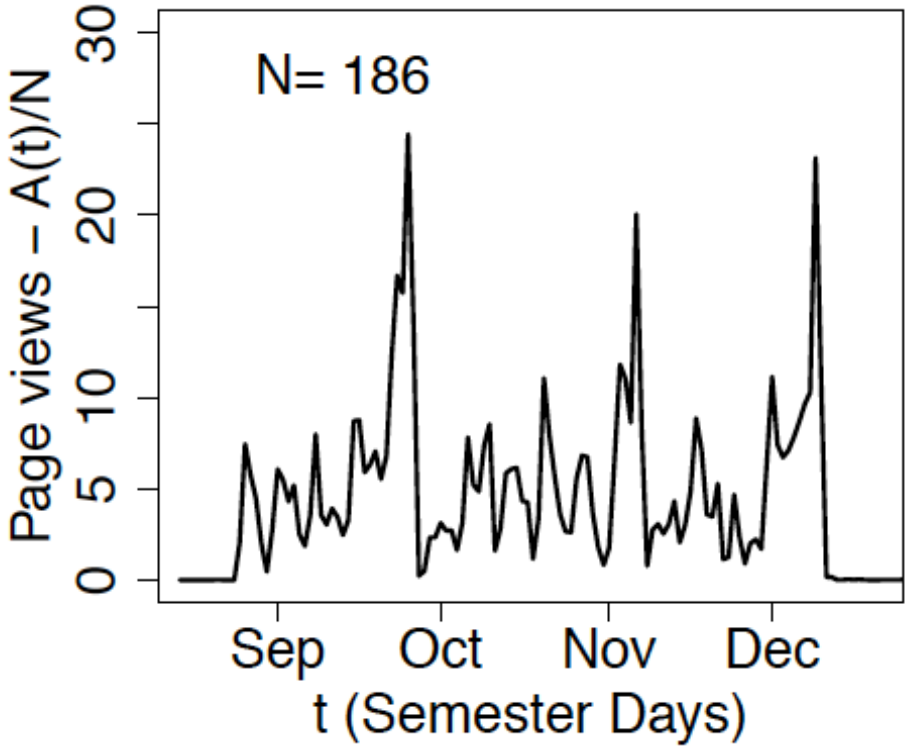
- Using Examity in our courses, but there are several others
  - Webcam
  - Screen sharing
- Check:
  - Identity
  - Desk
- Online proctor keeping eye on student and screen
- The first exam in each semester will be chaos!
  - Have some low-stakes first "quiz" for everybody to get used to this!

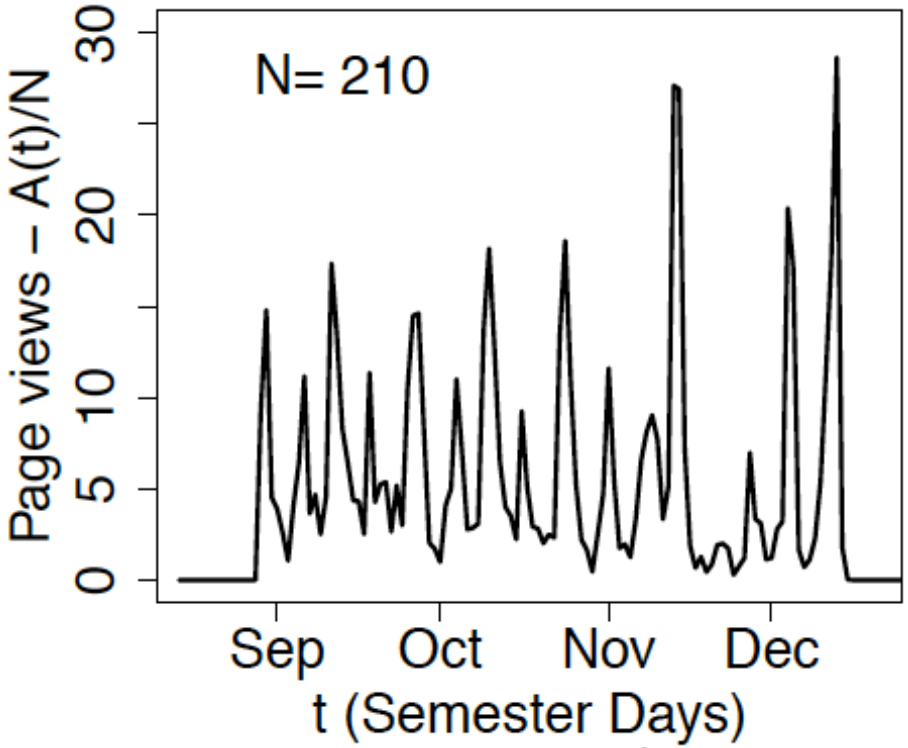
No. 4: Students don't read until they have to

- Cramming
- Big problem in online courses, as it is easy to fall behind
- Cannot track usage of normal textbook, but actually can see when electronic resources are used
- Turns out: more small tests work better than few exams
  - Even though they are painful

No. 4: Students don't read until they have to

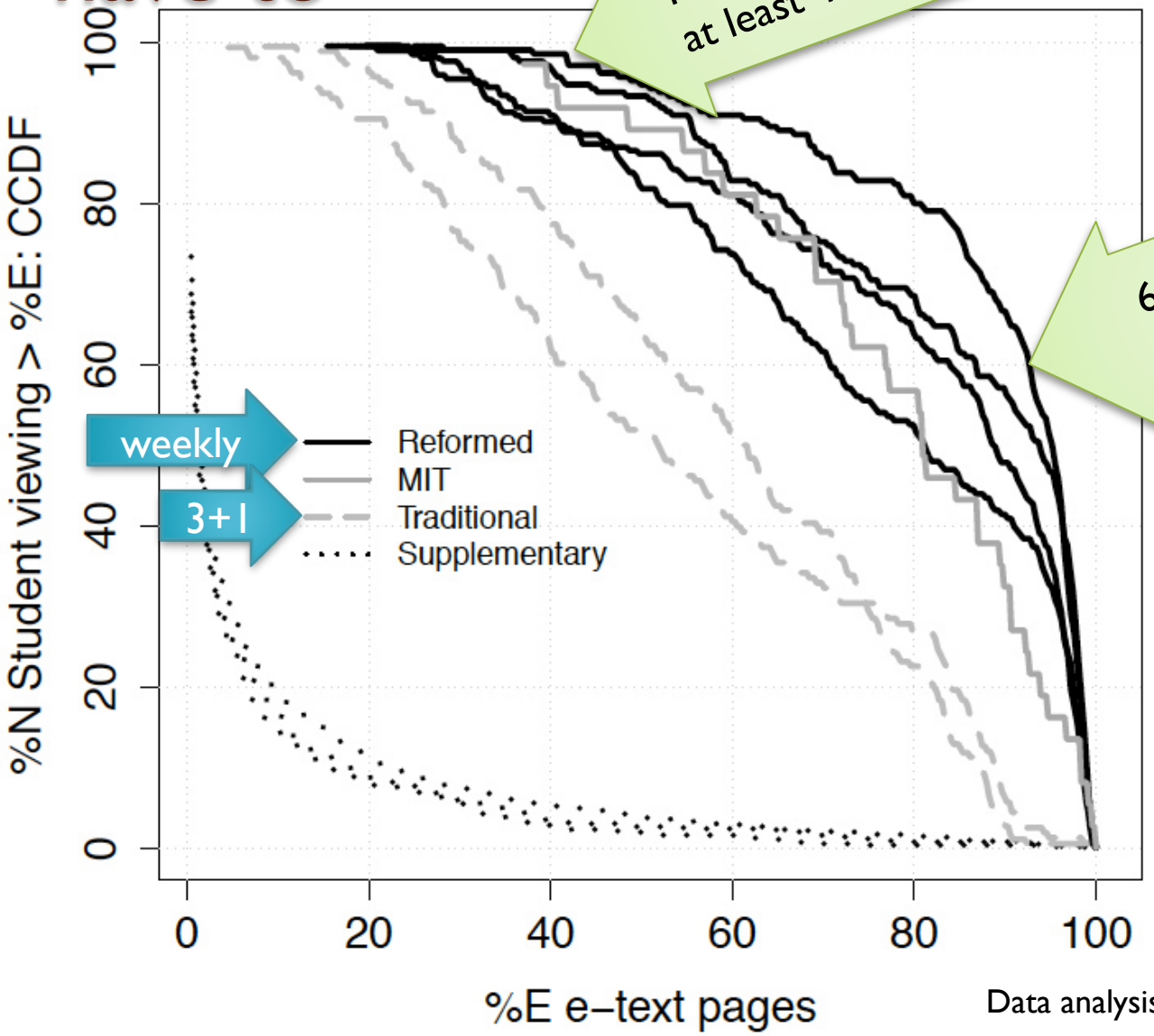
- Two midterms + final (left graph), weekly exams (right graph)
- Guess when these exams took place





Data analysis: Daniel Seaton, MIT

No. 4: Students don't [illegible] until they have to

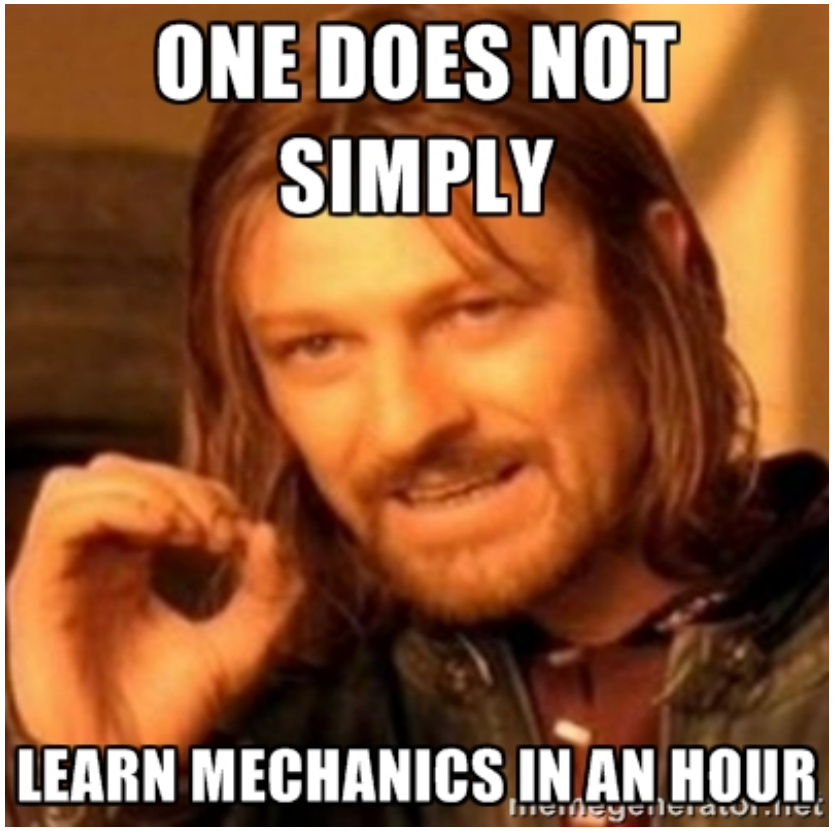


Move students into the same "diligence" class as MIT students

Data analysis: Daniel Seaton, MIT

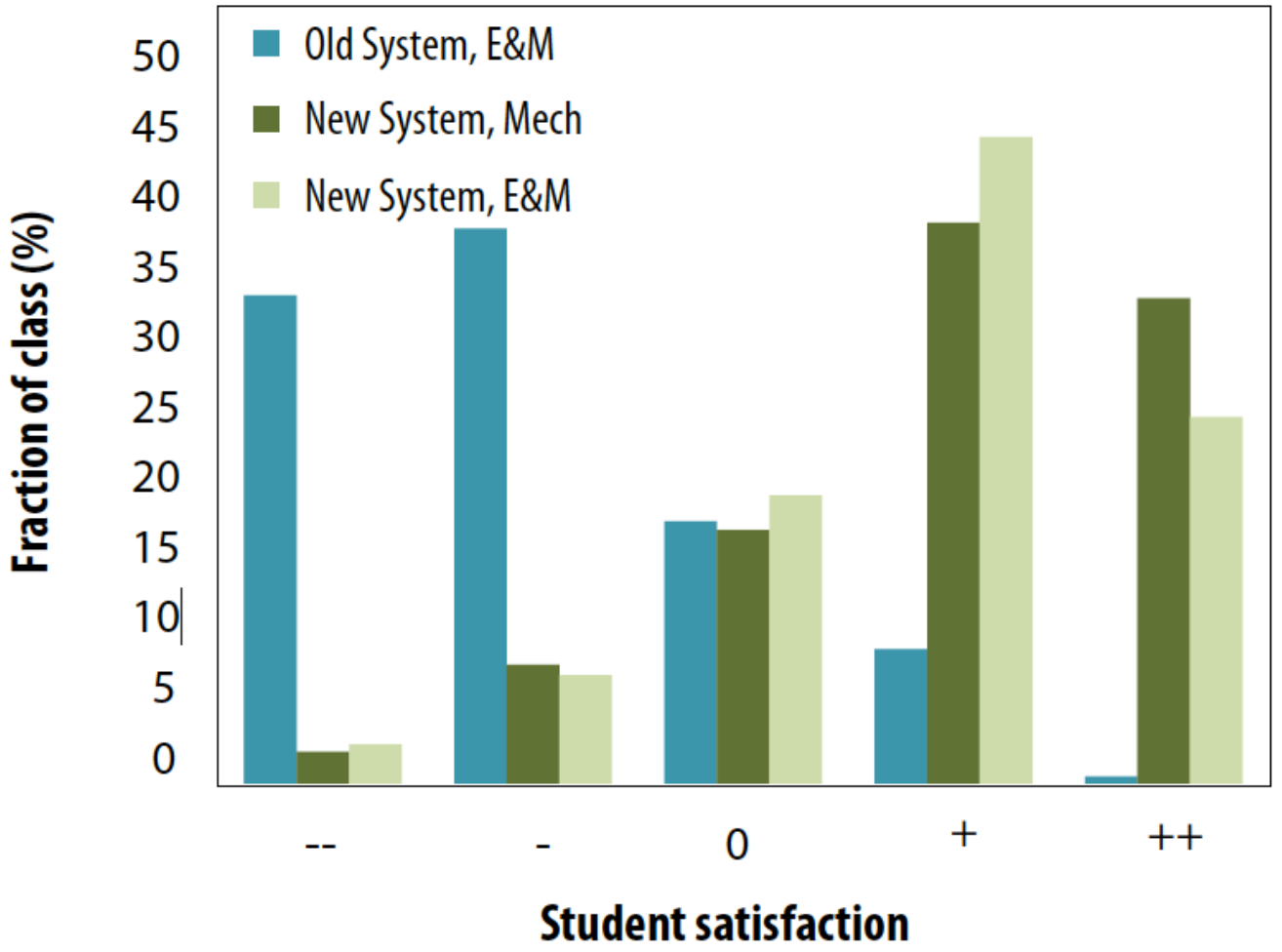
No. 4: Students don't read until they have to

- So, not surprisingly, more frequent exams lead to more frequent access of the electronic textbook
  - More distributed over time
  - More pages total



No. 4: Students don't read until they have to

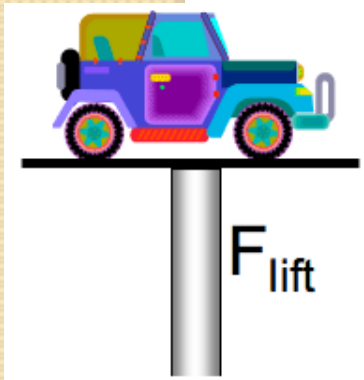
- More exams, unhappy students?



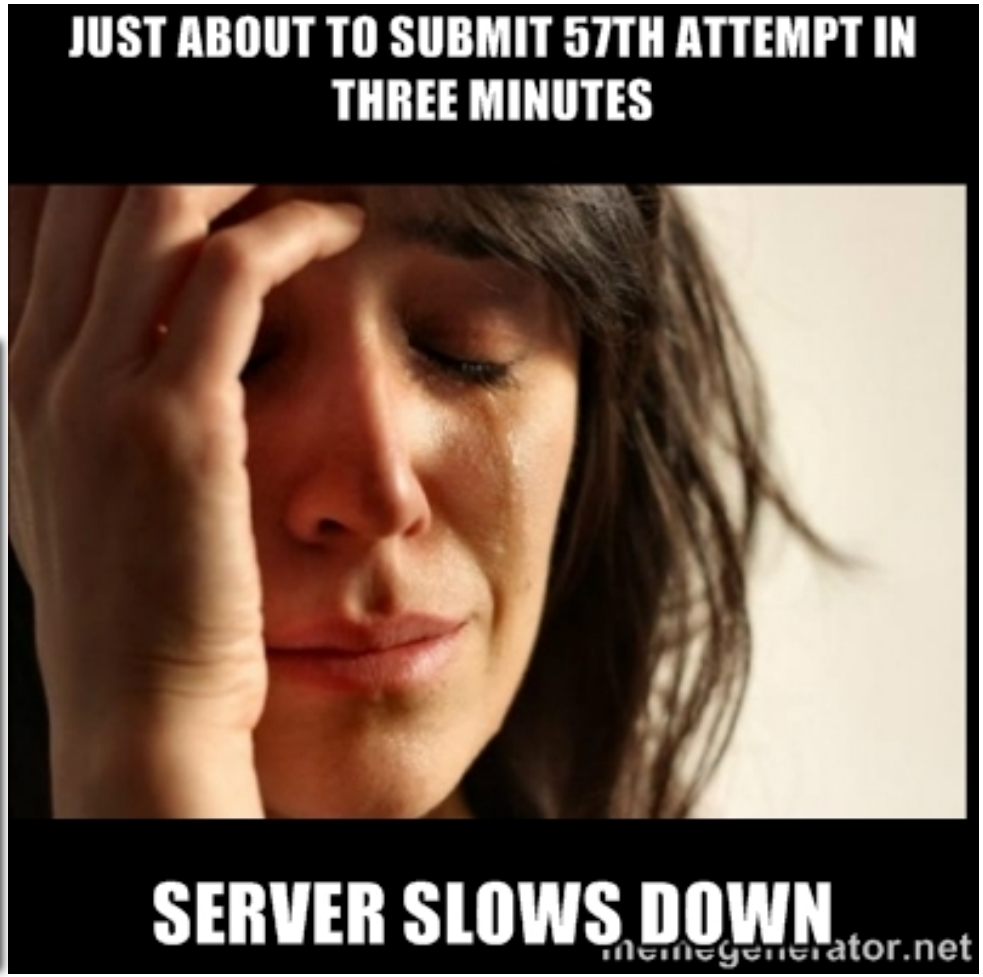
James T. Laverty, Wolfgang Bauer, Gerd Kortemeyer, and Gary Westfall, *Want to Reduce Guessing and Cheating While Making Students Happier? Give More Exams!*, The Physics Teacher **50**, 540-543 (2012)

No. 5: Guess what? Students are guessing

- Submitting "random" guesses to online homework
- Numerical problems

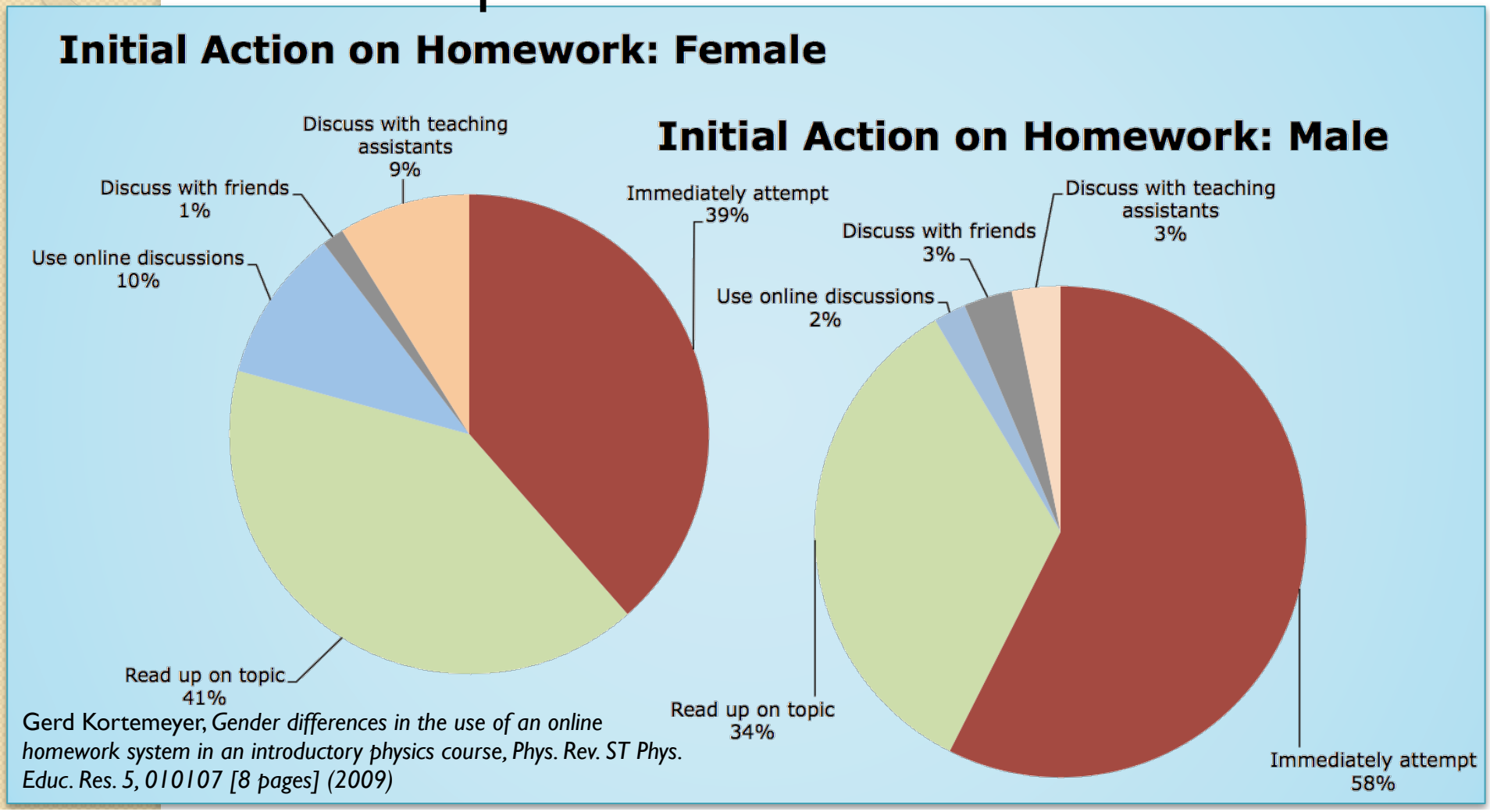


A car (mass of 990 kg) is sitting on a car lift in a shop (neglect the mass of the lift itself). While the car is being lowered, it is speeding up with 3.3 m/s^2. What is the magnitude of the lifting force?



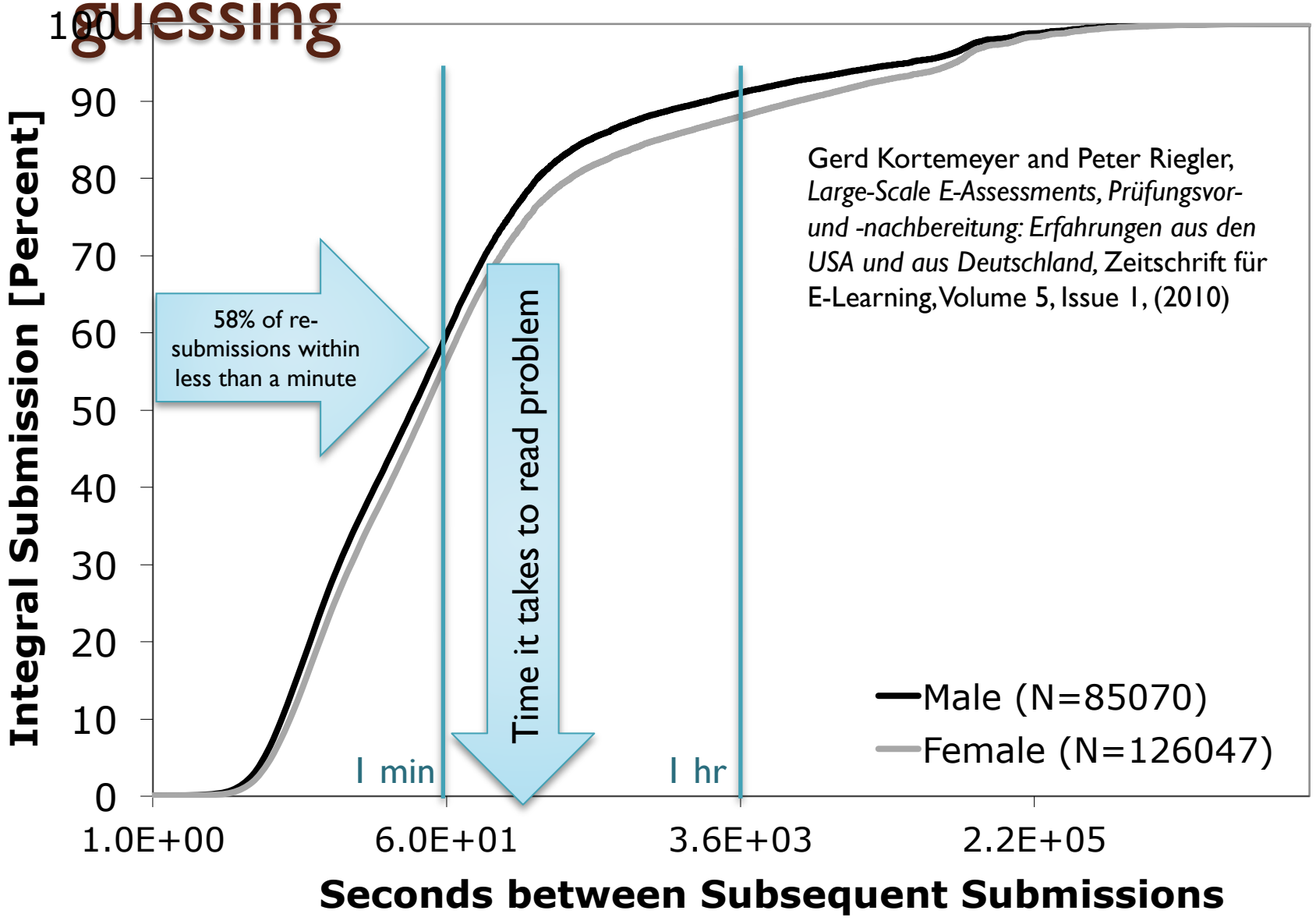
No. 5: Guess what? Students are guessing

- Self-reported: what do students do?



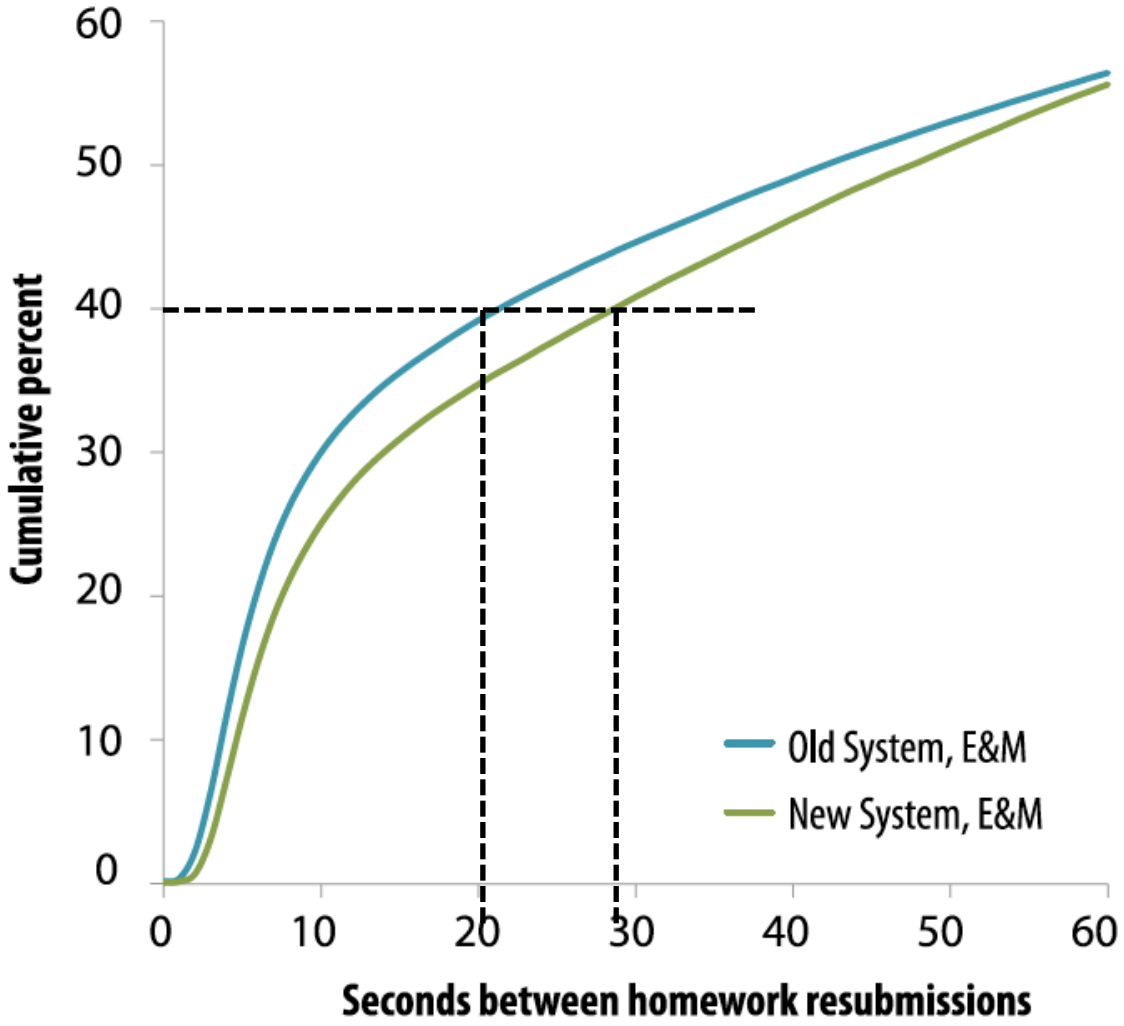
Gerd Kortemeyer, *Gender differences in the use of an online homework system in an introductory physics course, Phys. Rev. ST Phys. Educ. Res. 5, 010107 [8 pages] (2009)*

No. 5: Guess what? Students are guessing



No. 5: Guess what? Students are guessing

- Once again: More frequent exams?



James T. Laverty, Wolfgang Bauer, Gerd Kortemeyer, and Gary Westfall, *Want to Reduce Guessing and Cheating While Making Students Happier? Give More Exams!*, The Physics Teacher **50**, 540-543 (2012)

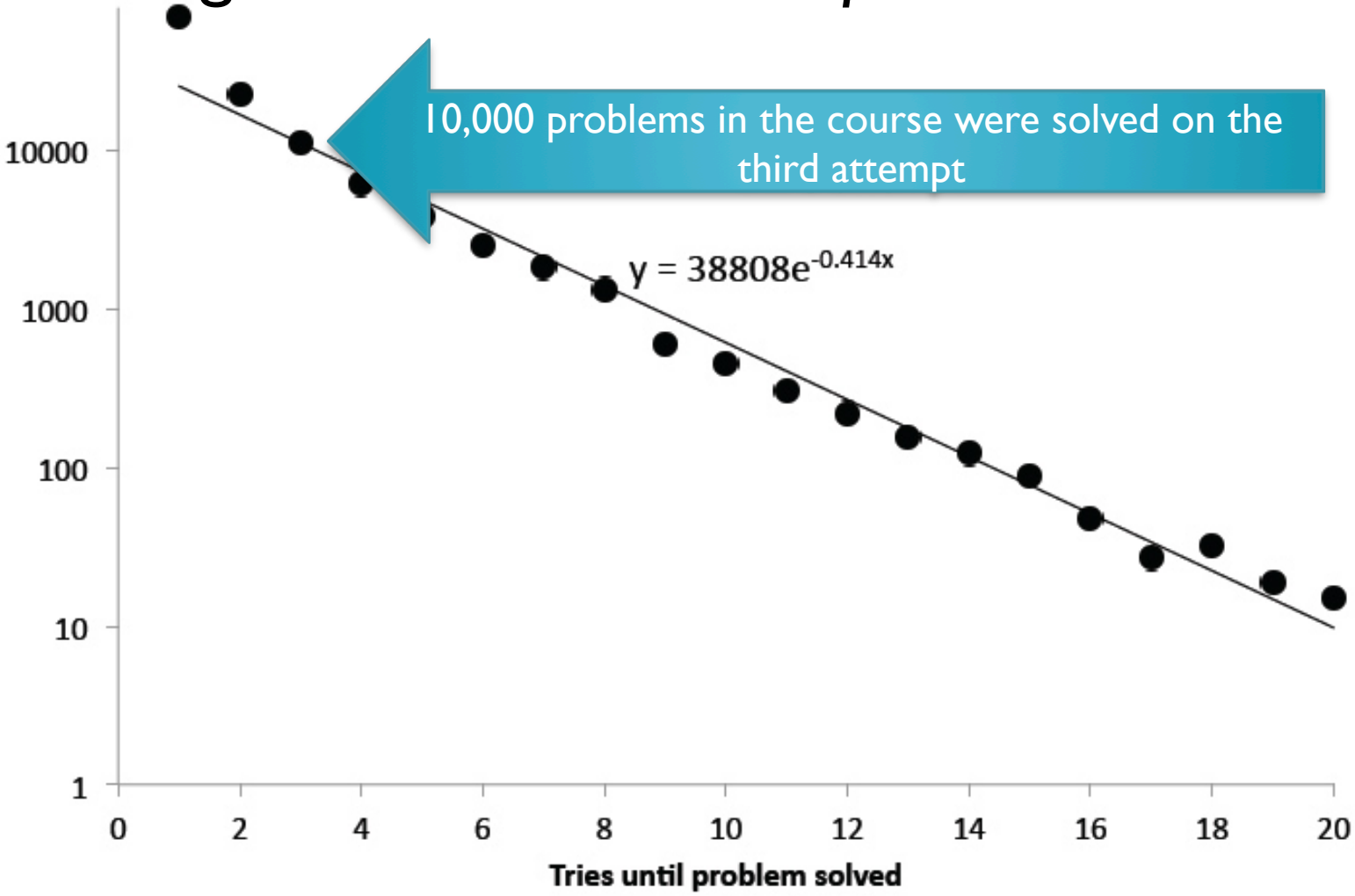
No. 5: Guess what? Students are guessing

- Maybe just give students less allowed tries on homework?

	Low Number of Allowed Tries	High Number of Allowed Tries
Possibly Good	• Better exam preparation • Less grade-inflation	• Better mastery-based formative assessment • Encouragement • Less whining
Possibly Bad	• Discouragement • Copying • More whining	• Random guessing • False sense of security

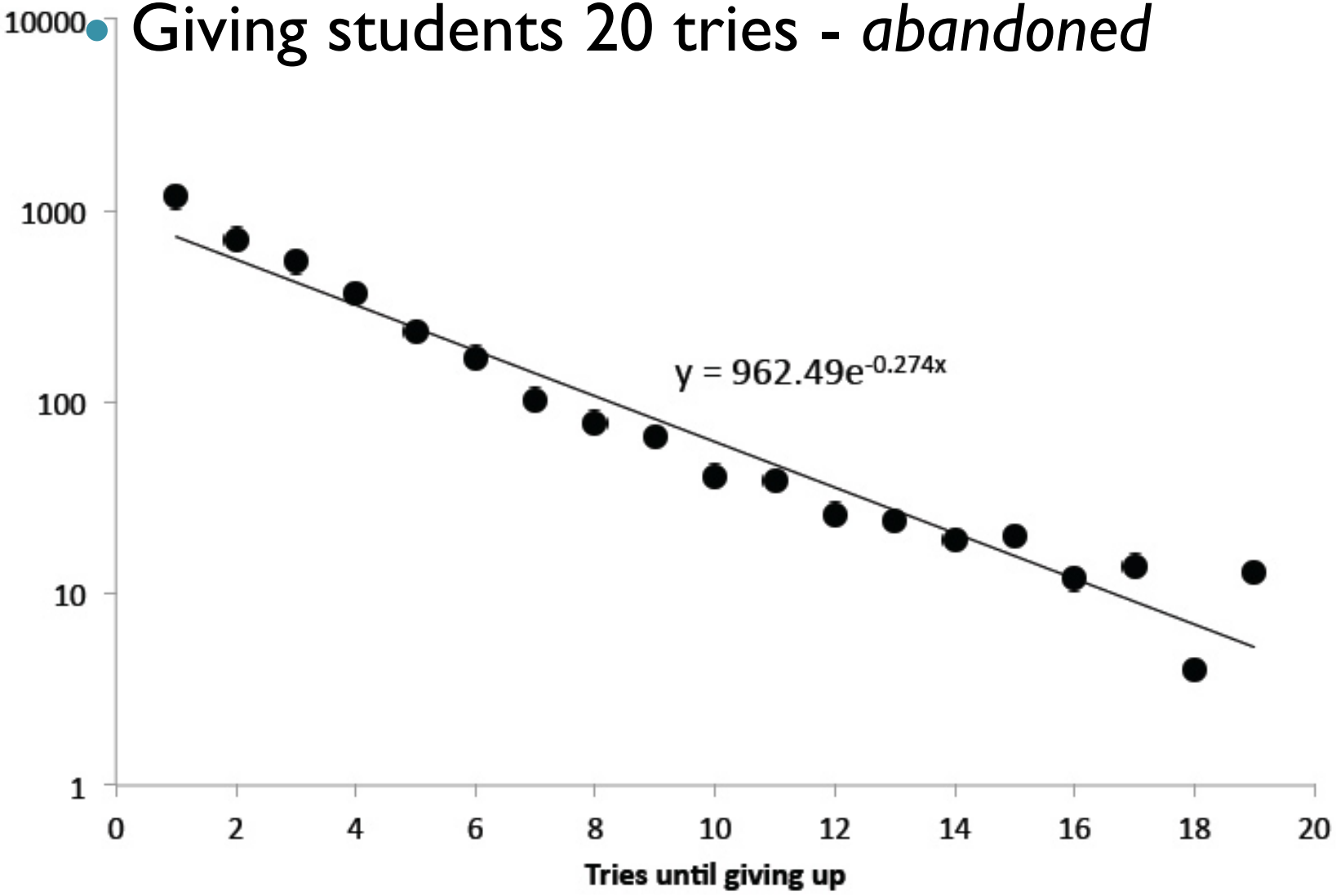
No. 5: Guess what? Students are guessing

- Giving students 20 tries – *problems solved*



No. 5: Guess what? Students are guessing

- Giving students 20 tries - *abandoned*



No. 5: Guess what? Students are guessing

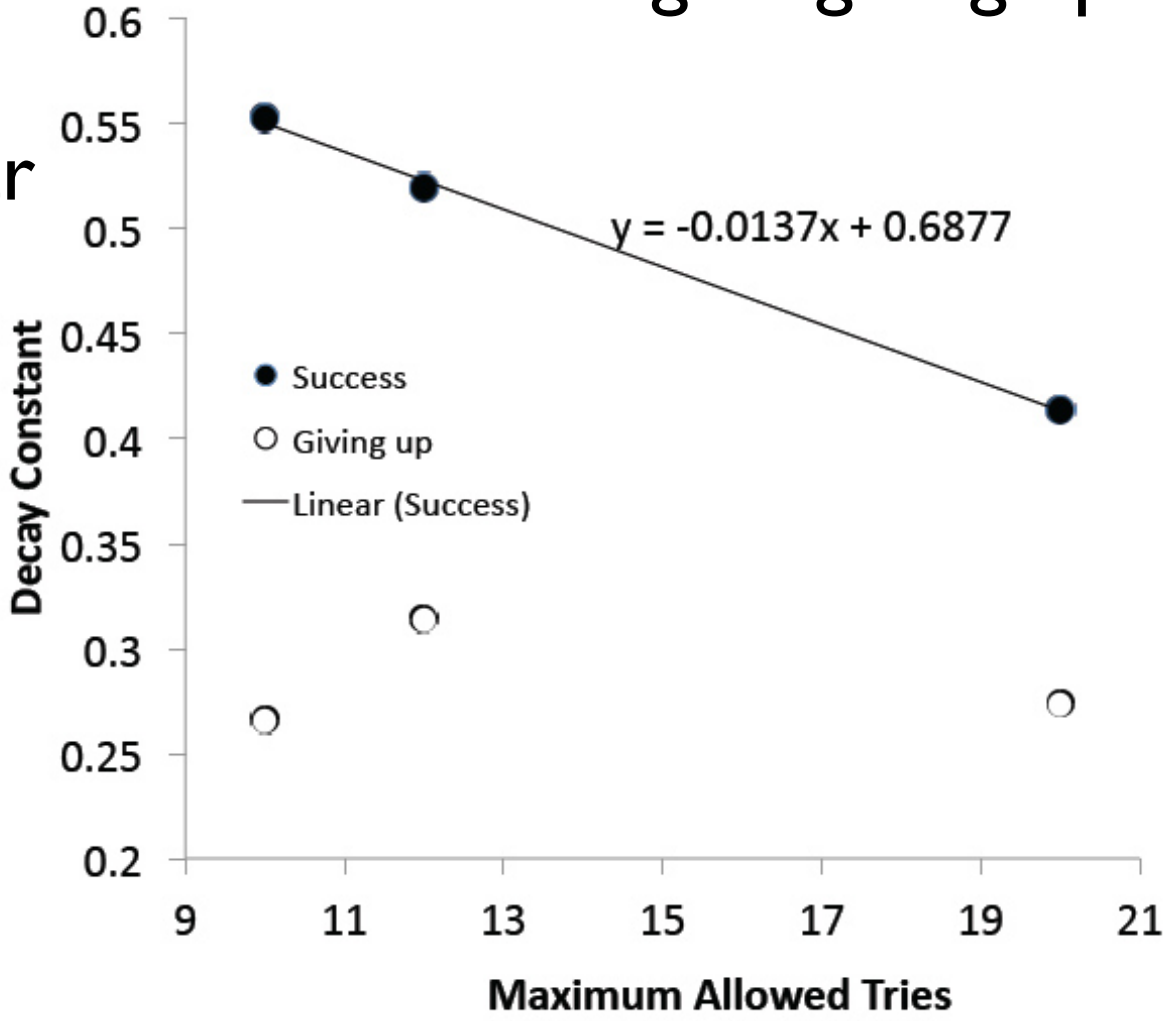
- Comparing three classes:
  10 tries, 12 tries, and 20 tries max.
- Surprisingly, for all classes, both success and giving up follow

$$\Delta N_s(n) = N_{s,0} \exp(-\lambda_s n)$$
$$\Delta N_a(n) = N_{a,0} \exp(-\lambda_a n)$$

- Tries are independent of each other!
- Lambdas are like probabilities

No. 5: Guess what? Students are guessing

- "Probabilities" of succeeding or giving up on a particular attempt

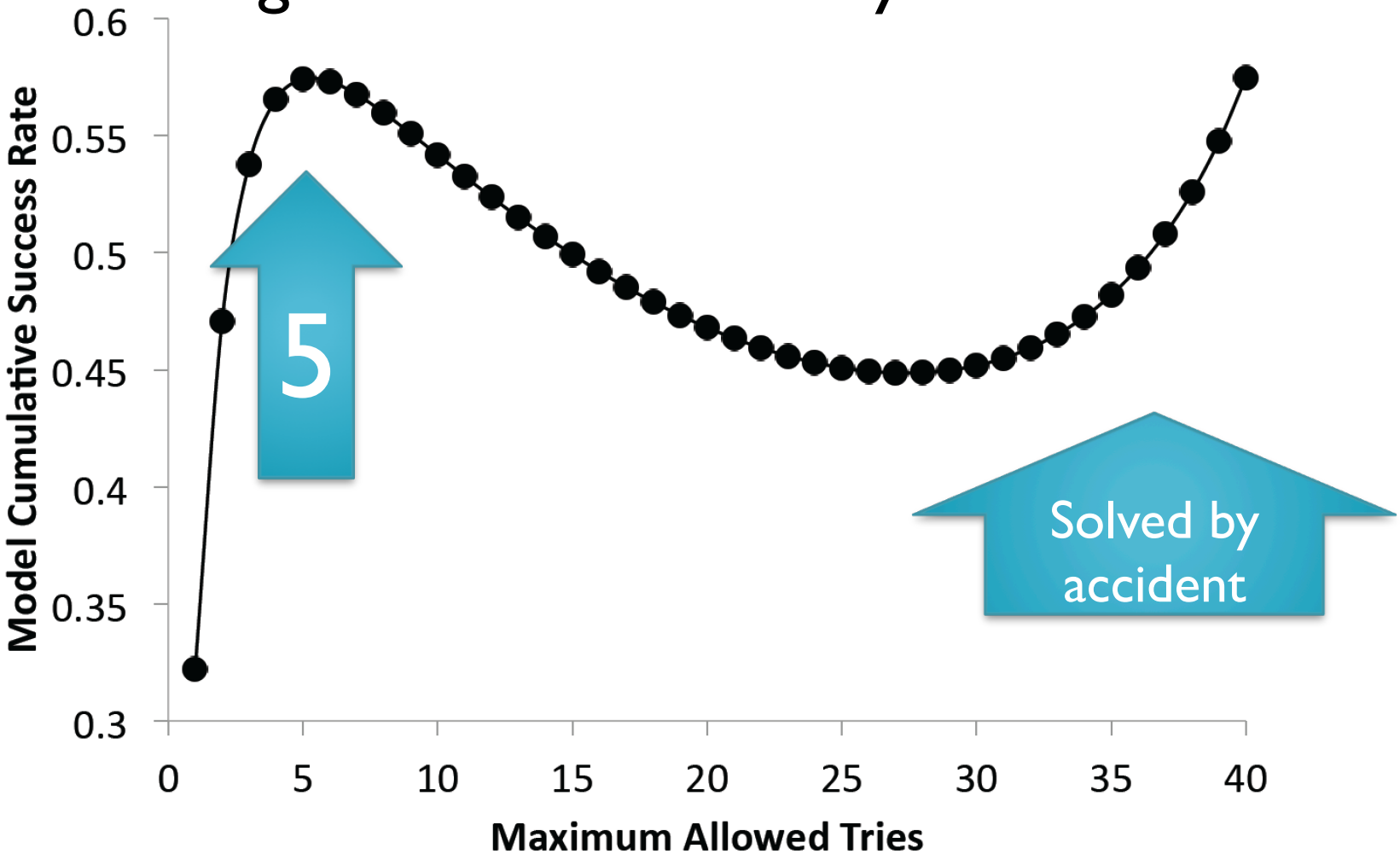


No. 5: Guess what? Students are guessing

- Students do not really profit from earlier tries
- Giving more tries reduces the probability of success on a particular try
- Also: total amount of successfully solved homework remains about the same

No. 5: Guess what? Students are guessing

- Using this model of "decay constants"

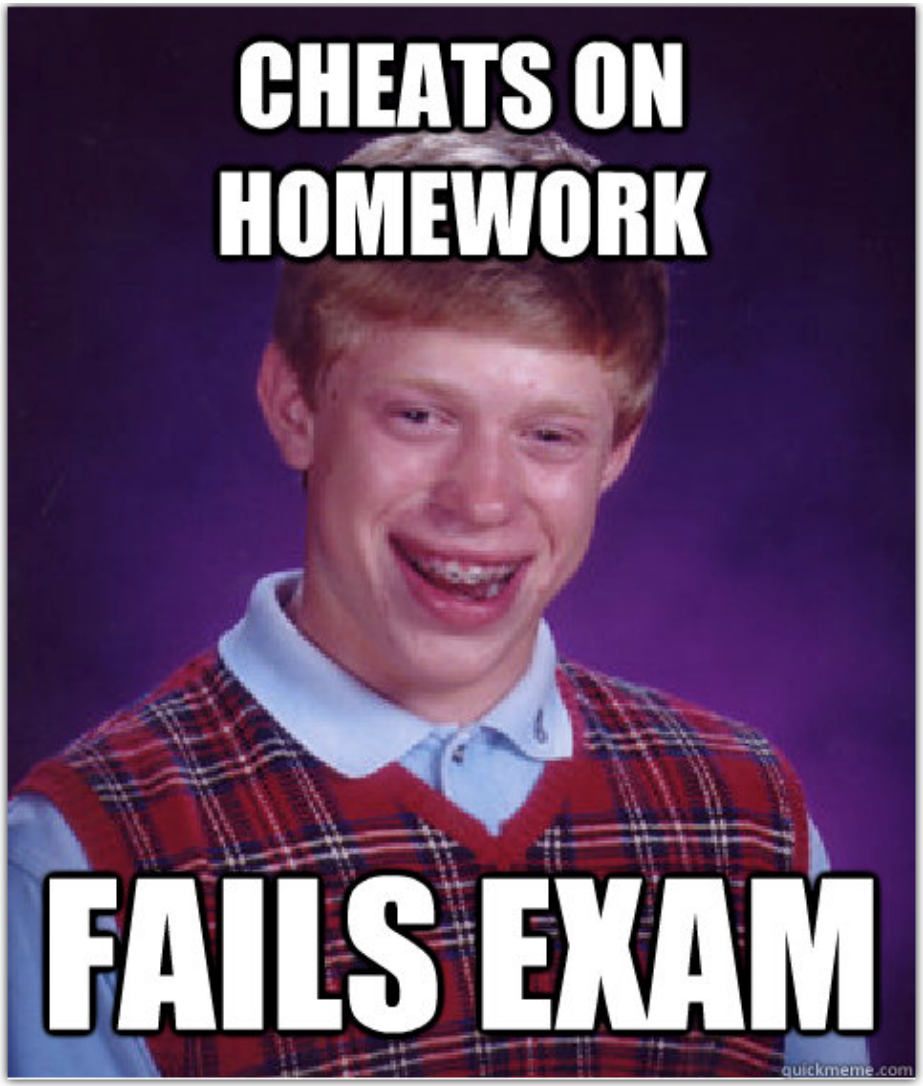


No. 6: Students copy. Copy that?

- Now the most unpleasant unproductive behavior: cheating

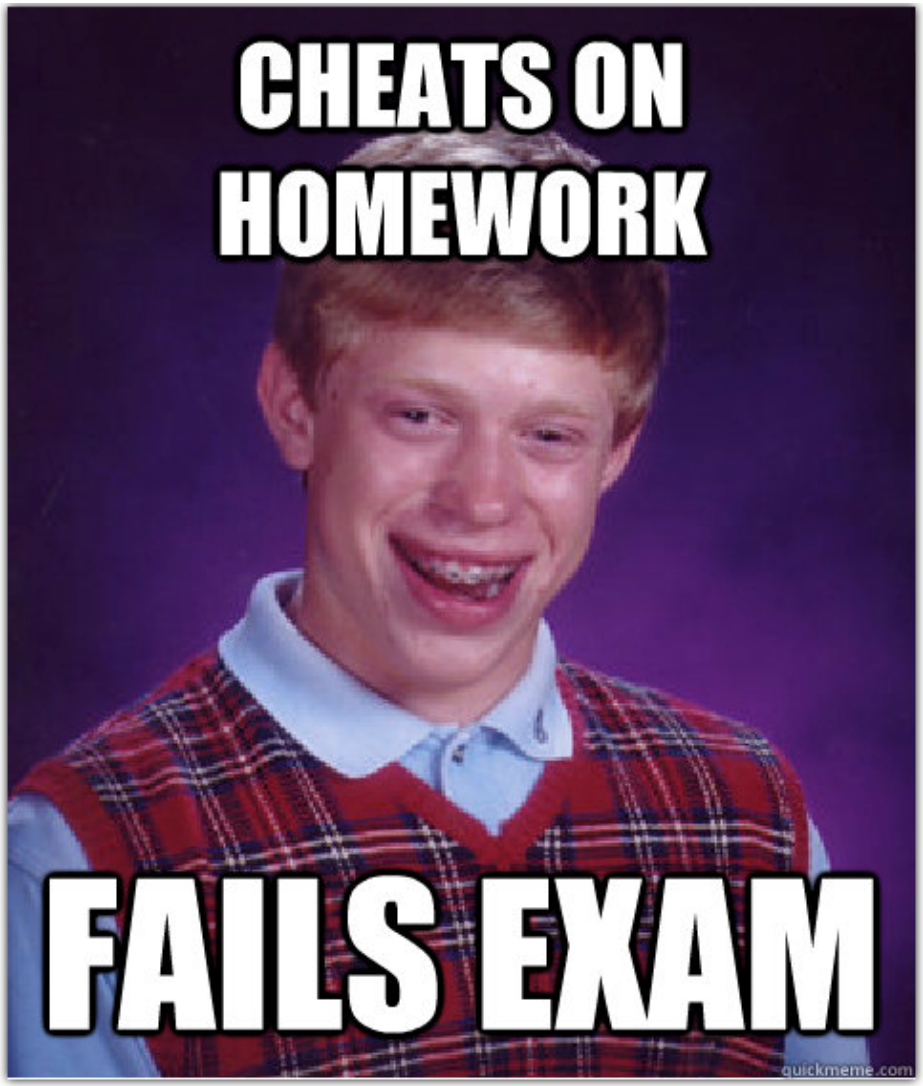
No. 6: Students copy. Copy that?

- First reaction: simplistic view, just do nothing



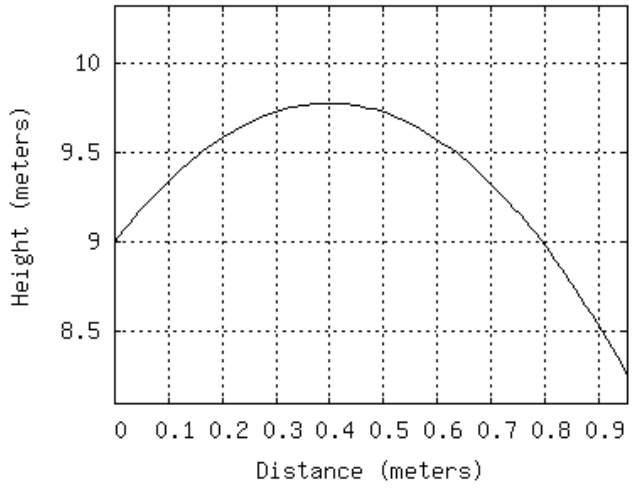
No. 6: Students copy. Copy that?

- But is this even true?
- Study at MSU: sanctioned versus non-sanctioned discussion forums



Kashy, D.A., Albertelli, G., Bauer, W., Kashy, E., Thoennessen, T., *Influence Of Non-Moderated And Moderated Discussion Sites On Student Success*, Journal of Asynchronous Learning Networks, Vol.7, No. 1 (2003)

No. 6: Students copy. Copy that?



The plot shows the trajectory (height versus distance) of an object launched at an angle of 75.6 degrees. What was the initial speed of the object? **4.0 m/s**
Computer's answer now shown above. Tries 0/12

Threaded View Chronological View Sorting/Filtering options Export?

Anonymous 1 (Fri Sep 22 01:26:29 2006 (EDT))

any hints to start?

Re: *Anonymous 2* (Fri Sep 22 01:56:48 2006 (EDT))

You need to find the Y component of velocity... you can do this by finding the height traveled (notice it does not start on the ground) and combining that with acceleration in a kinematics equation. From there use trig to get the original velocity.

Re: Re: *Anonymous 1* (Fri Sep 22 12:10:37 2006 (EDT))

how can we find the height traveled and how can we get the acceleration if we don't have the time?

Anonymous 3 (Fri Sep 22 16:41:27 2006 (EDT))

i'm lost on this one... can anyone help?

Re: *Anonymous 4* (Fri Sep 22 20:02:45 2006 (EDT))

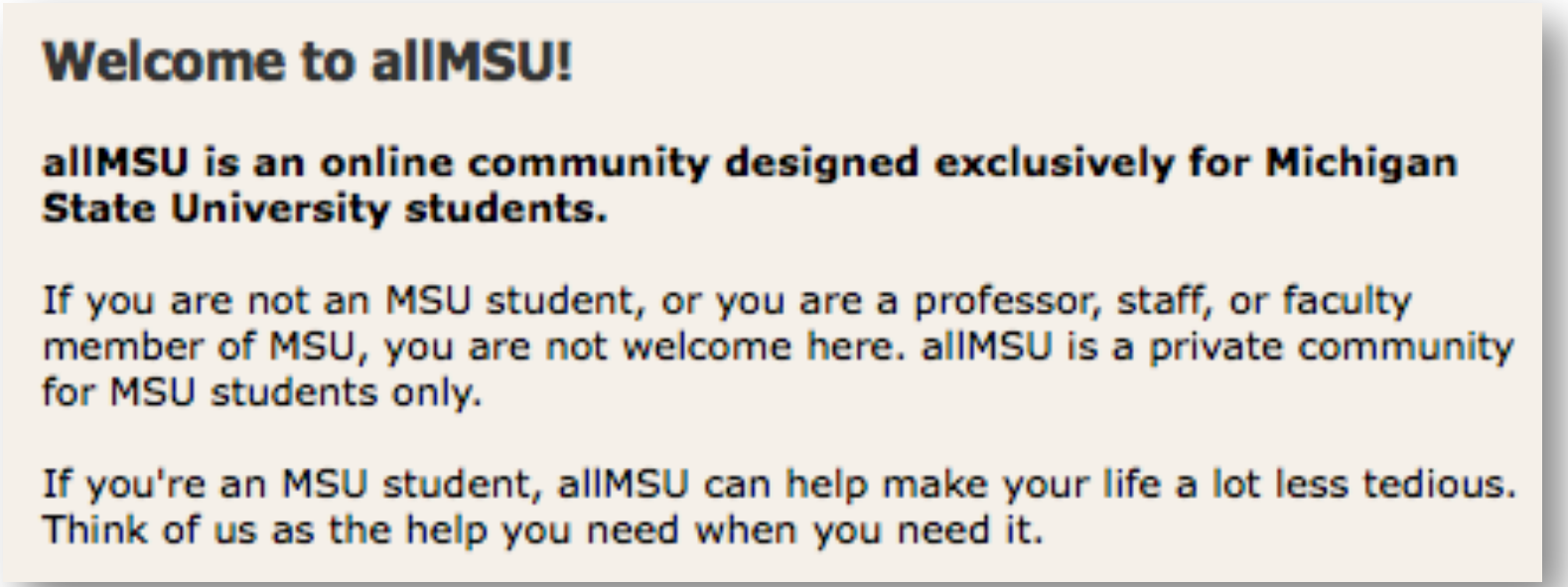
Use the squared kinematics equation - so Vf^2 = Vi^2 + 2a (Xf-Xi).

Sanctioned Discussions

Encouraged, since all students have different versions.

Feedback and peer-instruction.

No. 6: Students copy. Copy that?



Welcome to allMSU!

allMSU is an online community designed exclusively for Michigan State University students.

If you are not an MSU student, or you are a professor, staff, or faculty member of MSU, you are not welcome here. allMSU is a private community for MSU students only.

If you're an MSU student, allMSU can help make your life a lot less tedious. Think of us as the help you need when you need it.

Unsanctioned Discussions

Professors not welcome

No. 6: Students copy. Copy that?

- The course had sanctioned discussion site (with instructors present) and 3rd-party "cheat" site
  - For usage of non-sanctioned site, relied on student self-reporting
  - For usage of sanctioned site, data was available about "looking" and "posting"
- Result: 3rd party: bad; Sanctioned: good

Correlation coefficients and p-values

	3rd Party Percent	Post-sanctioned	Look-sanctioned
Homework	0.041 (0.655)	0.118 (0.016)	-0.109 (0.026)
Final Exam	-0.348 (0.001)	0.147 (0.003)	0.129 (0.008)
Midterm Exams	-0.352 (0.001)	0.166 (0.001)	0.160 (0.001)
Quizzes	-0.302 (0.001)	0.098 (0.044)	0.069 (0.157)
FCI Improvement	-0.151 (0.162)	0.121 (0.034)	0.152 (0.008)

No. 6: Students copy. Copy that?

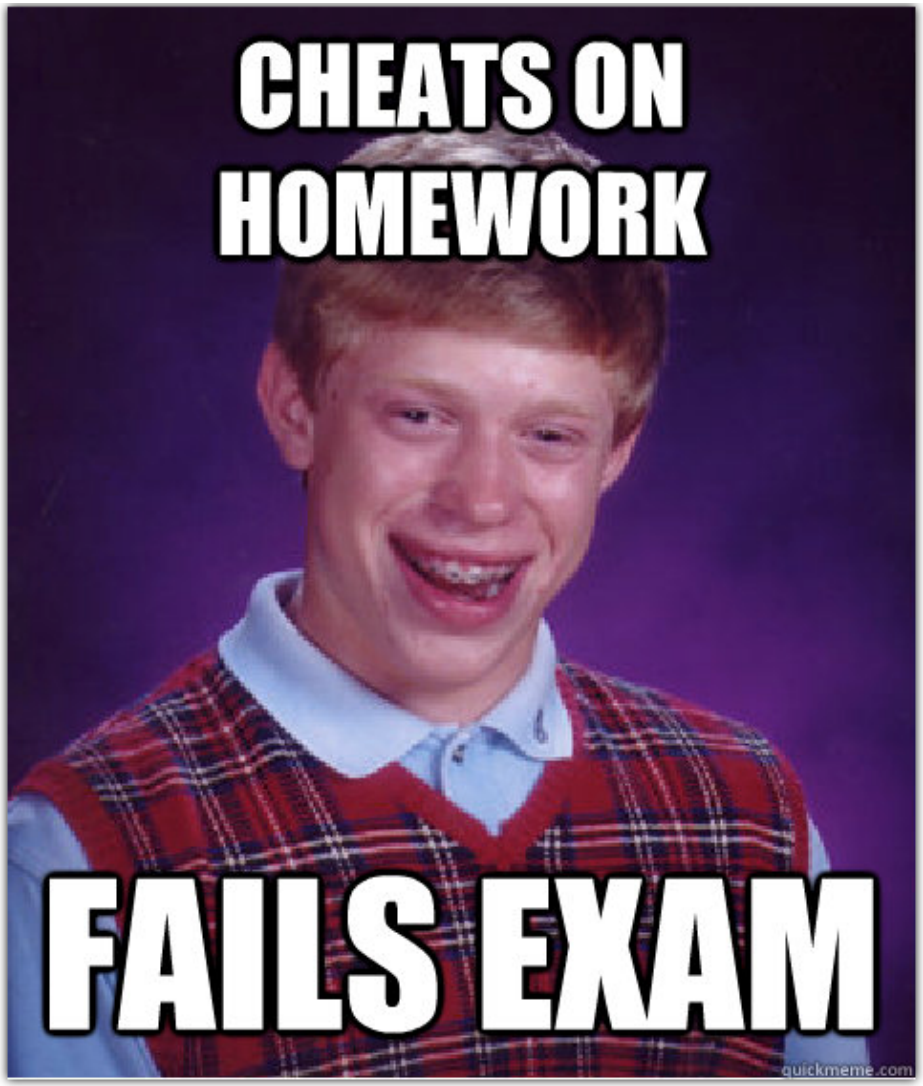
- Just the not-so-academically inclined students?
- Effect controlled for ACT scores
- Still: significant negative correlation with Midterm and Final exams.

Correlation coefficients and p-values

	3rd Party Percent	Post-sanctioned	Look-sanctioned
Homework	.024(.804)	.121(.018)	-.115(.024)
Final Exam	-.327(.001)	.126(.014)	.098(.056)
Midterm Exams	-.314(.001)	.116(.023)	.111(.030)
Quizzes	-.247(.009)	.045(.376)	.023(.654)
FCI Improvement	-.149(.192)	.081(.172)	.115(053)

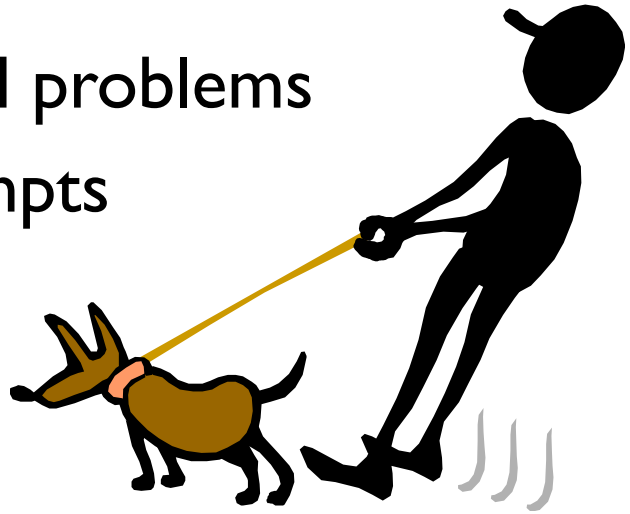
No. 6: Students copy. Copy that?

- So, yes, it's true, mostly
- But apart from "revenge" and "higher justice"
  - not really doing the students a service
  - frustrating to honest students
  - course morale suffers



No. 6: Students copy. Copy that?

- Second reaction: Let's hunt them down!
- Should be easy, since we have a lot of data:
  - Access times of pages and problems
  - Submission times of attempts
  - Entered answers
  - Online discussions



No. 6: Students copy. Copy that?

- So: find signature patterns of cheating

No. 6: Students copy. Copy that?

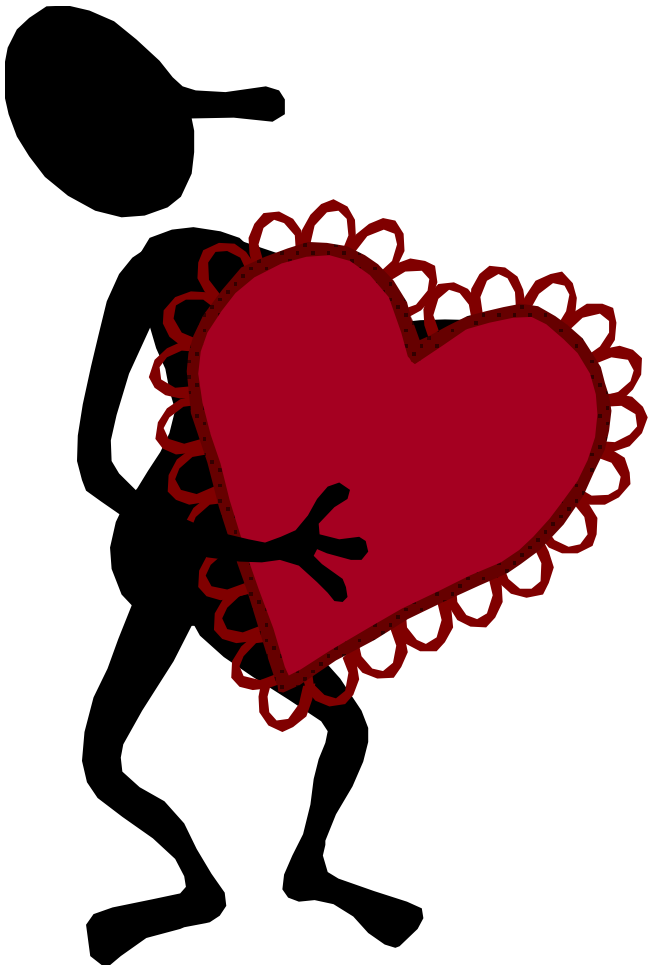
- In reality this is very hard
- Yes, there is a lot of data, but also a lot of noise:
  - Navigational events
  - Guessing
  - Working with printouts
  - Genuine collaborations
  - etc.
- One can do a lot of good statistics, but in the end one ends up with probabilities and confidence intervals

No. 6: Students copy. Copy that?

- Too cumbersome: if you find a signature event, what can you actually prove?
  - Good for research, not for "law enforcement"
- And: do you really want to police your course?

No. 6: Students copy. Copy that?

- Third reaction: let's be proactive instead of reactive!



No. 6: Students copy. Copy that?

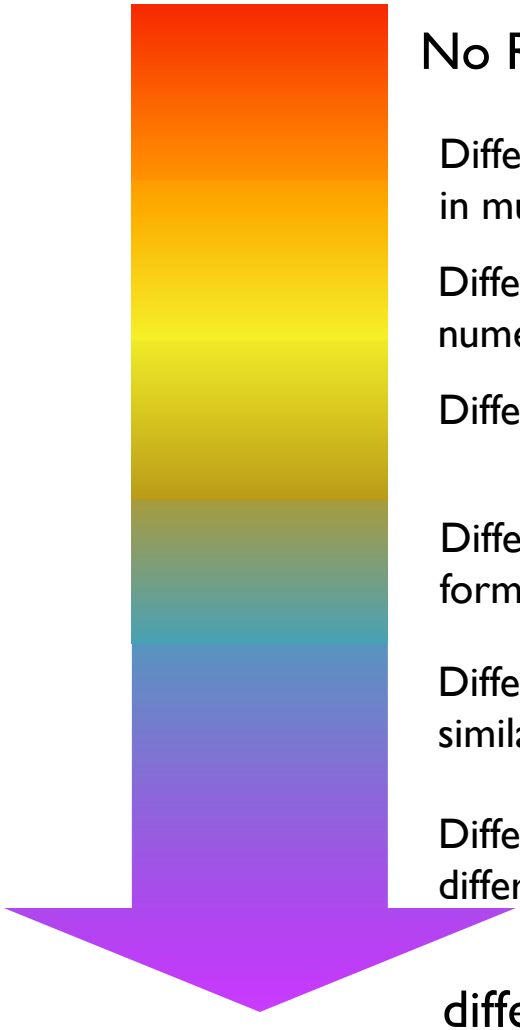
- Reaction 3.1:
  Tell them how bad cheating is
- Gave students paper with results on 3rd-party "cheating" site and correlated exam performance
  - Did not tell them about the difference between correlation and causation
- What do you think happened?

No. 6: Students copy. Copy that?

- Self-reported use of the 3rd-party site **increased**
  - Risk was now calculable
- Backfired!

No. 6: Students copy. Copy that?

- Reaction 3.2: randomizing problems
- Making doing the homework easier than copying it



No Randomization

Different order of options in multiple choice

Different numbers in numerical problems

Different options

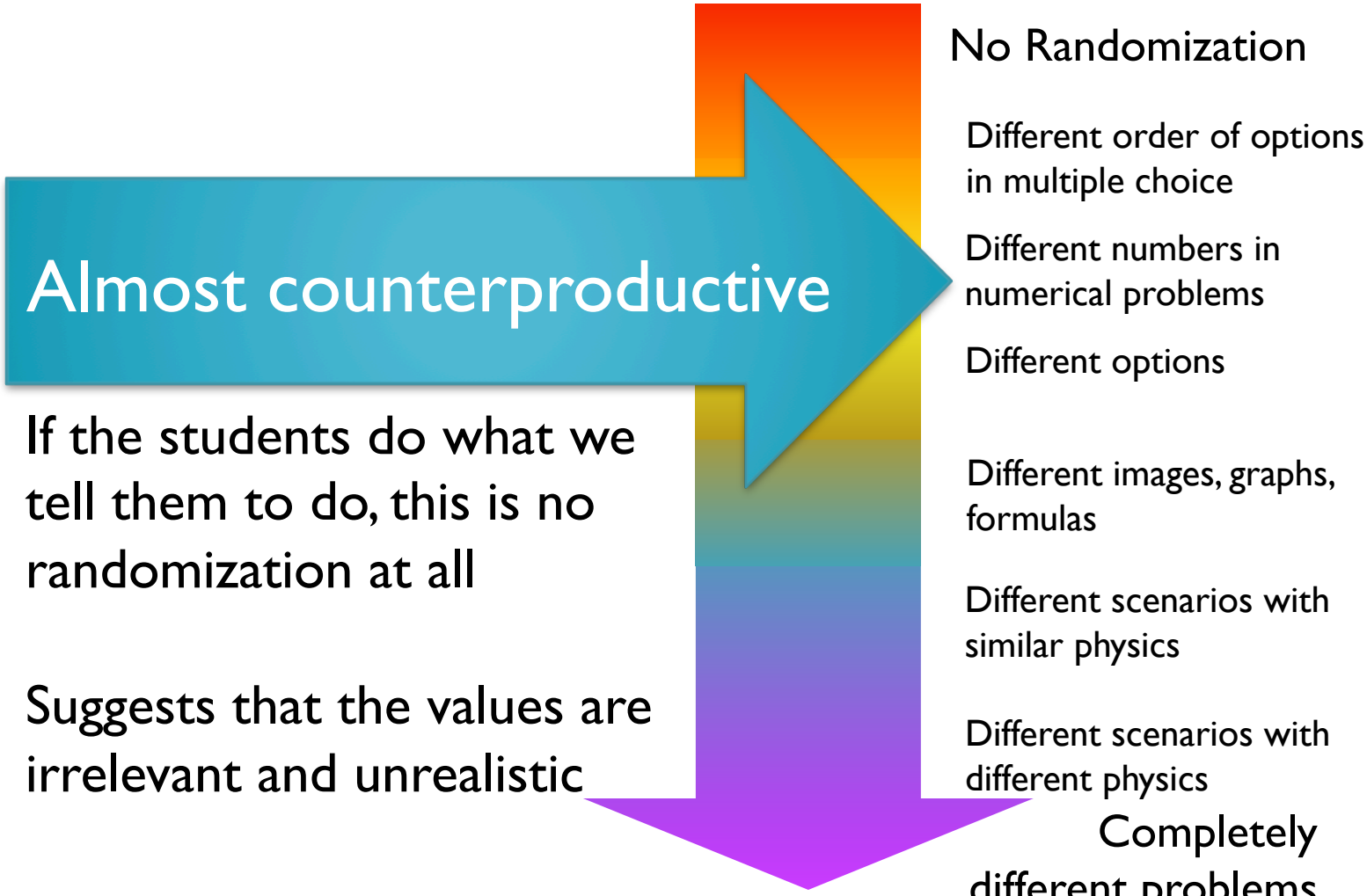
Different images, graphs, formulas

Different scenarios with similar physics

Different scenarios with different physics

Completely different problems

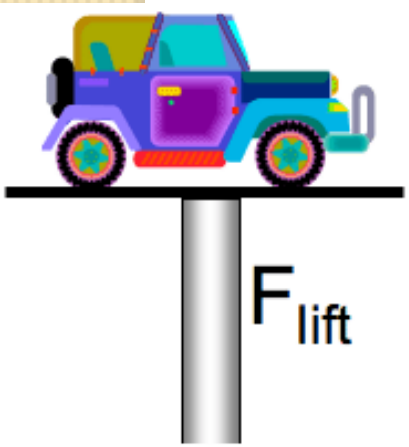
No. 6: Students copy. Copy that?



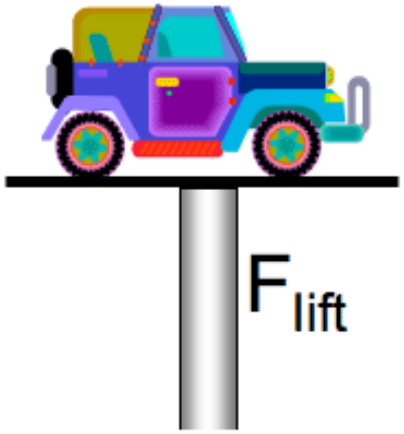
If the students do what we tell them to do, this is no randomization at all

Suggests that the values are irrelevant and unrealistic

No. 6: Students copy. Copy that?



A car (mass of 750
sitting on a car lift in a shop (neglect th
of the lift itself). While the car is being l
up, it is speeding up with 2.3 m/s^2. Wha
the magnitude of the lifting force?



A car (mass of 990 kg) is sitting on a car lift in a shop (neglect the mass of the lift itself). While the car is being lowered, it is speeding up with 3.3 m/s^2. What is the magnitude of the lifting force?

A car (mass of 940 kg) is
a car lift in a shop (neglect the mass
of the lift itself). While the car is being lifted
up, it is slowing down with 2.1 m/s^2. What is
the magnitude of the lifting force?

Lifting/lowering,
speeding up/slowing down,
different numbers

No. 6: Students copy. Copy that?

A plate capacitor has been charged. Its plates are then pushed closer together after they had been disconnected from the voltage source.

- The capacitance increases.
- The capacitance stays the same.
- The capacitance decreases.

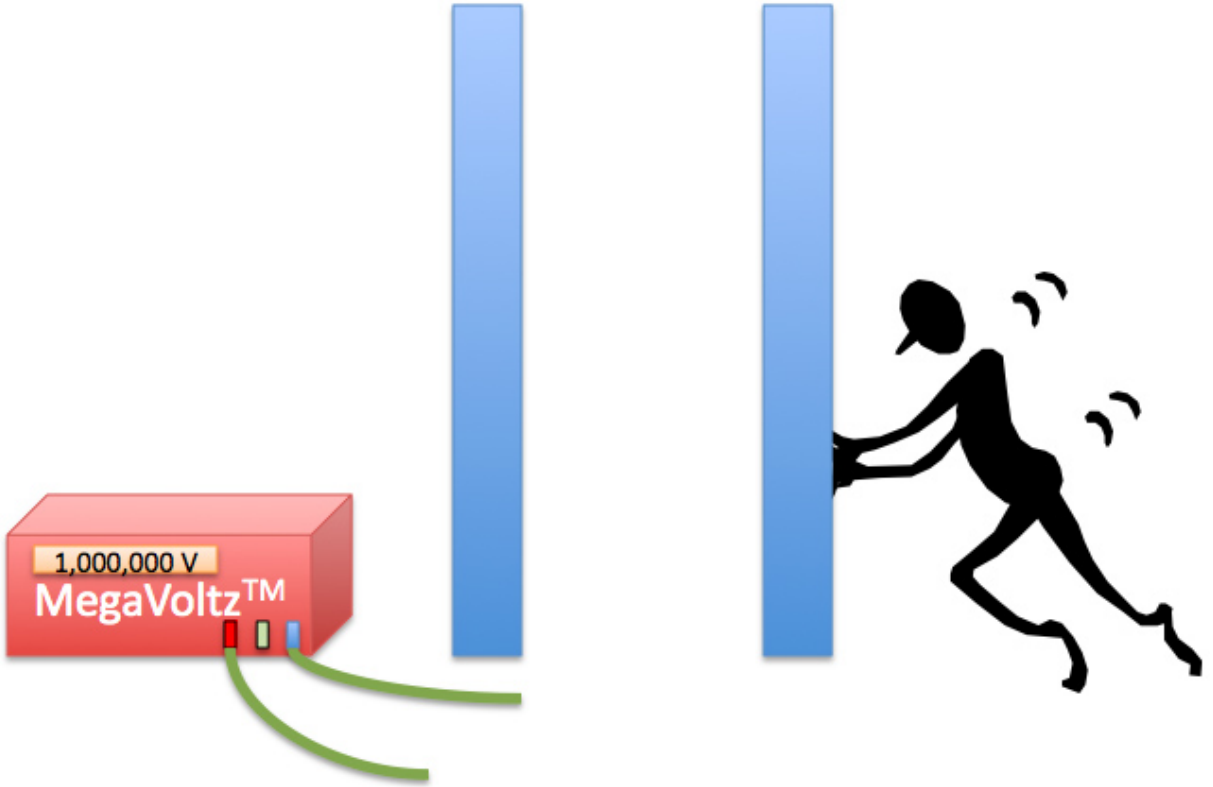
Submit Answer Tries 0

- The voltage increases.
- The voltage stays the same.
- The voltage decreases.

Submit Answer Tries 0

- The charge increases.
- The charge stays the same.
- The charge decreases.

Submit Answer Tries 0



No. 6: Students copy. Copy that?

A plate capacitor has been charged. Its plates are then pulled further apart while still connected to the voltage source.

- The capacitance increases.
- The capacitance stays the same.
- The capacitance decreases.

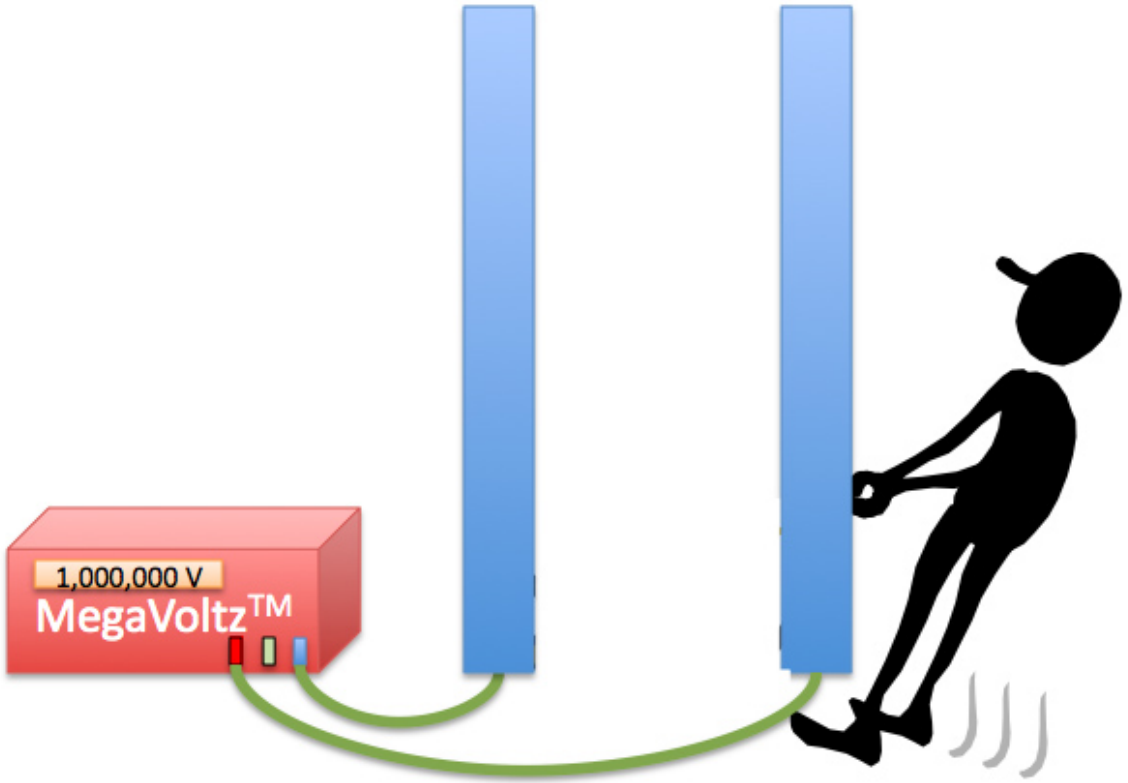
Submit Answer Tries 0

- The voltage increases.
- The voltage stays the same.
- The voltage decreases.

Submit Answer Tries 0

- The charge increases.
- The charge stays the same.
- The charge decreases.

Submit Answer Tries 0



No. 6: Students copy. Copy that?

Two ways how the paper could slide off the fridge:

•Magnet slides off paper
•Paper and magnet
slide off fridge

Depending on values, one or the other decides.

A sheet of paper is attached to the door of your refrigerator by a magnet. The coefficient of static friction between the fridge door and the paper is 0.6, and between the paper and the magnet is 1.4. The mass of the paper is 2 gram, the mass of the magnet is 10 gram. What is the magnitude of the minimum force with which the magnet must be attracted to the fridge, so the note sticks?

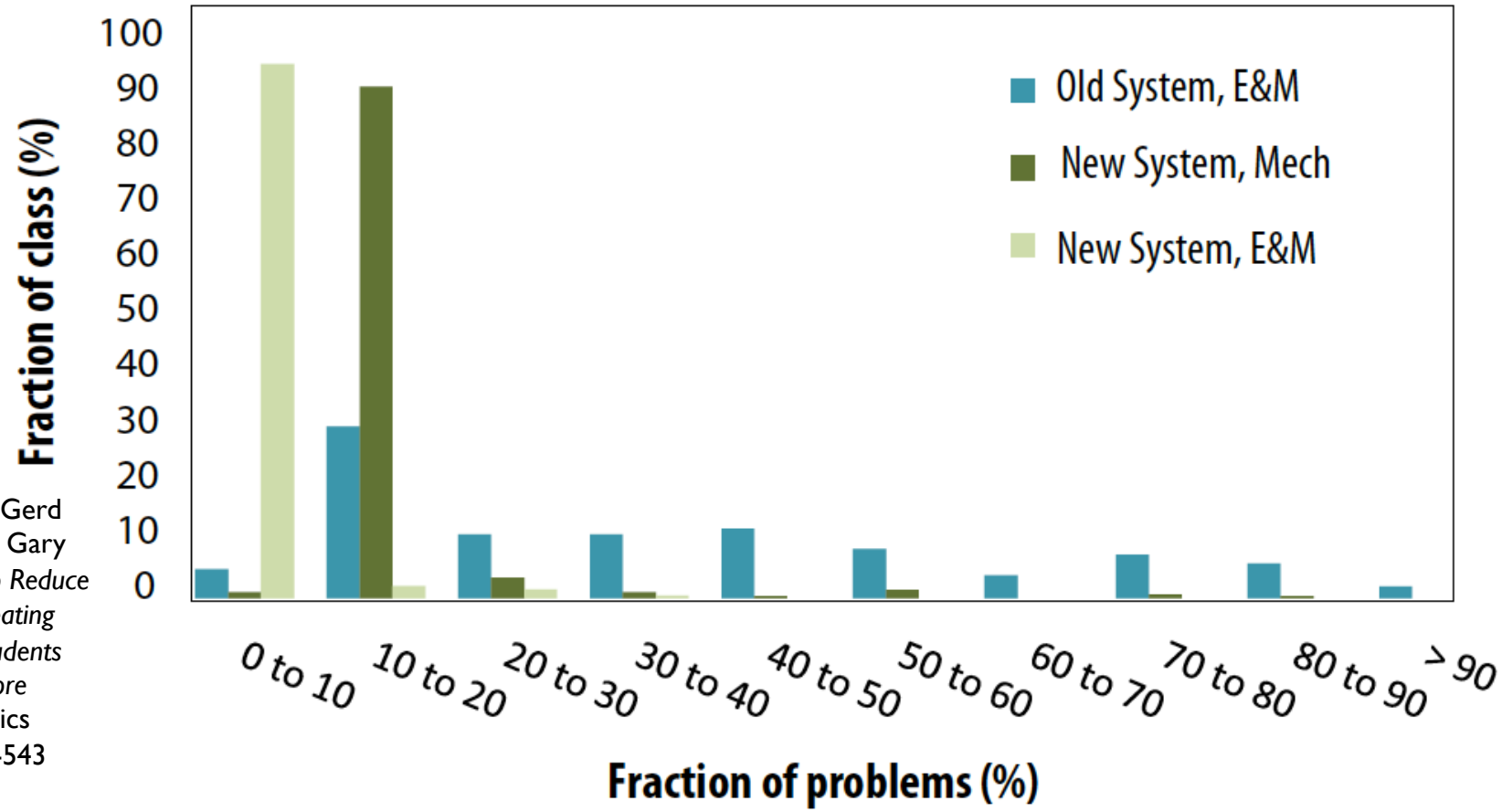
Submit Answer Tries 0

No. 6: Students copy. Copy that?

- Fourth attempt (again):
  more frequent exams

No. 6: Students copy. Copy that?

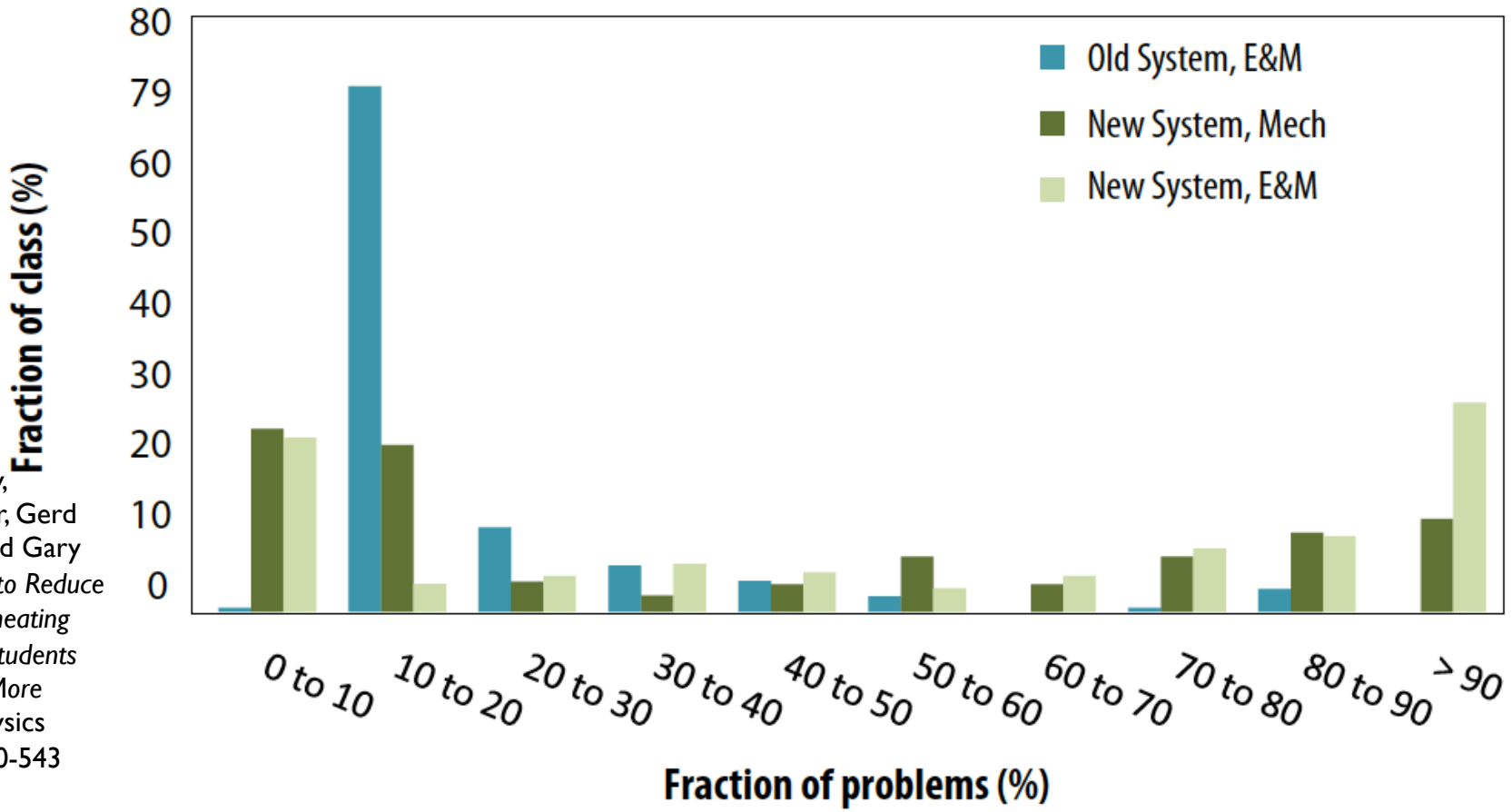
- Self-reported use of 3rd party cheat sites



James T. Laverty, Wolfgang Bauer, Gerd Kortemeyer, and Gary Westfall, *Want to Reduce Guessing and Cheating While Making Students Happier? Give More Exams!*, The Physics Teacher **50**, 540-543 (2012)

No. 6: Students copy. Copy that?

- Sanctioned internal discussions



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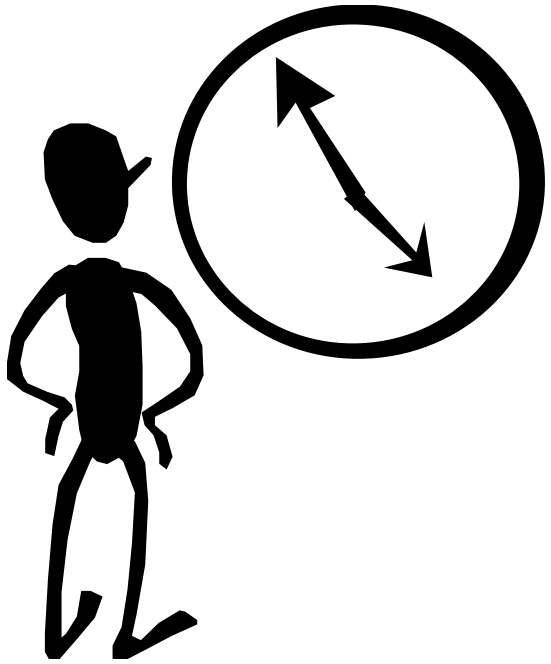
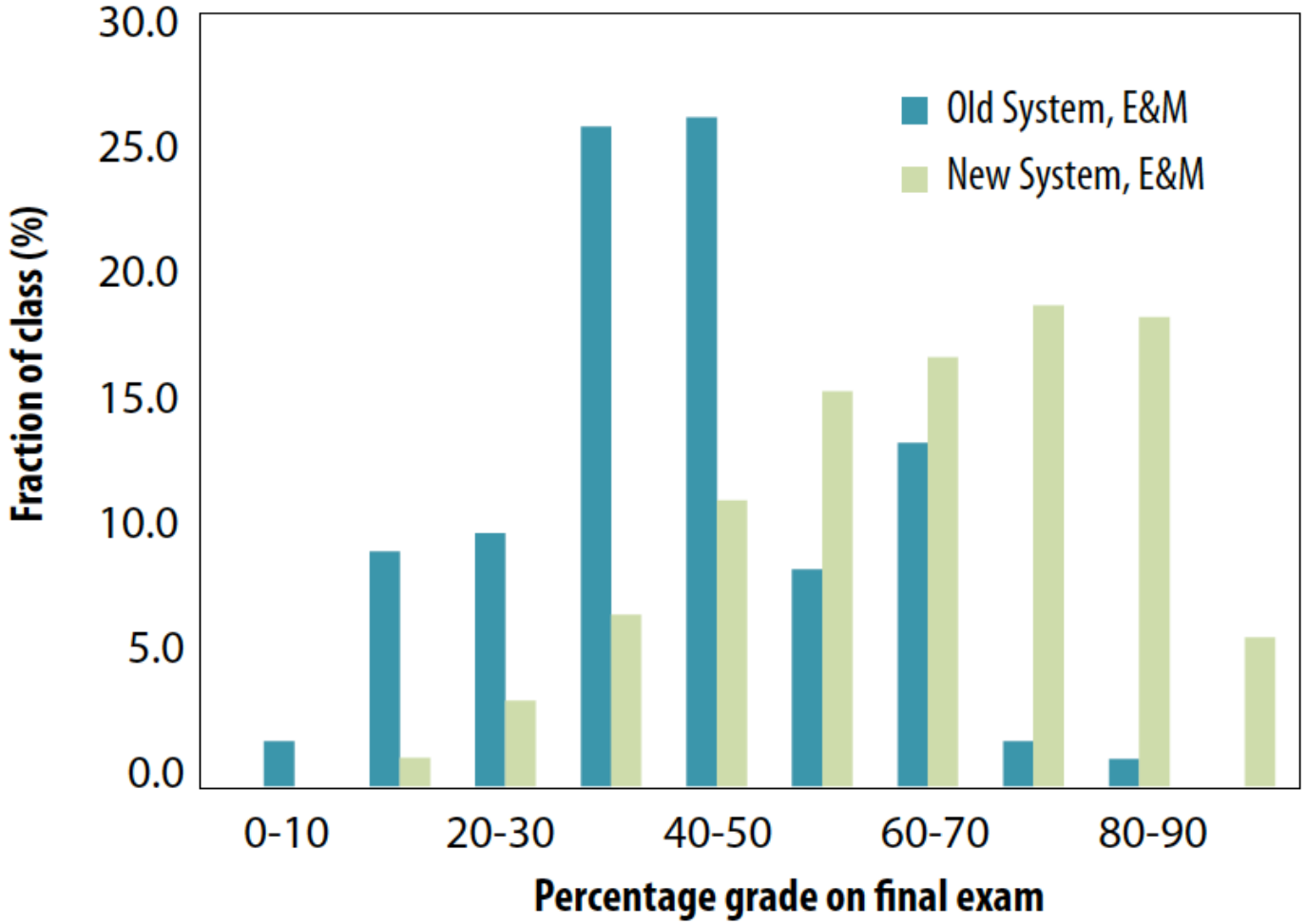
No. 6: Students copy. Copy that?

- It makes no sense to cheat or guess on homework if the exam is immediately imminent
  - No time to cram later



No. 6: Students copy. Copy that?

- The proof is in the pudding: Final Exam



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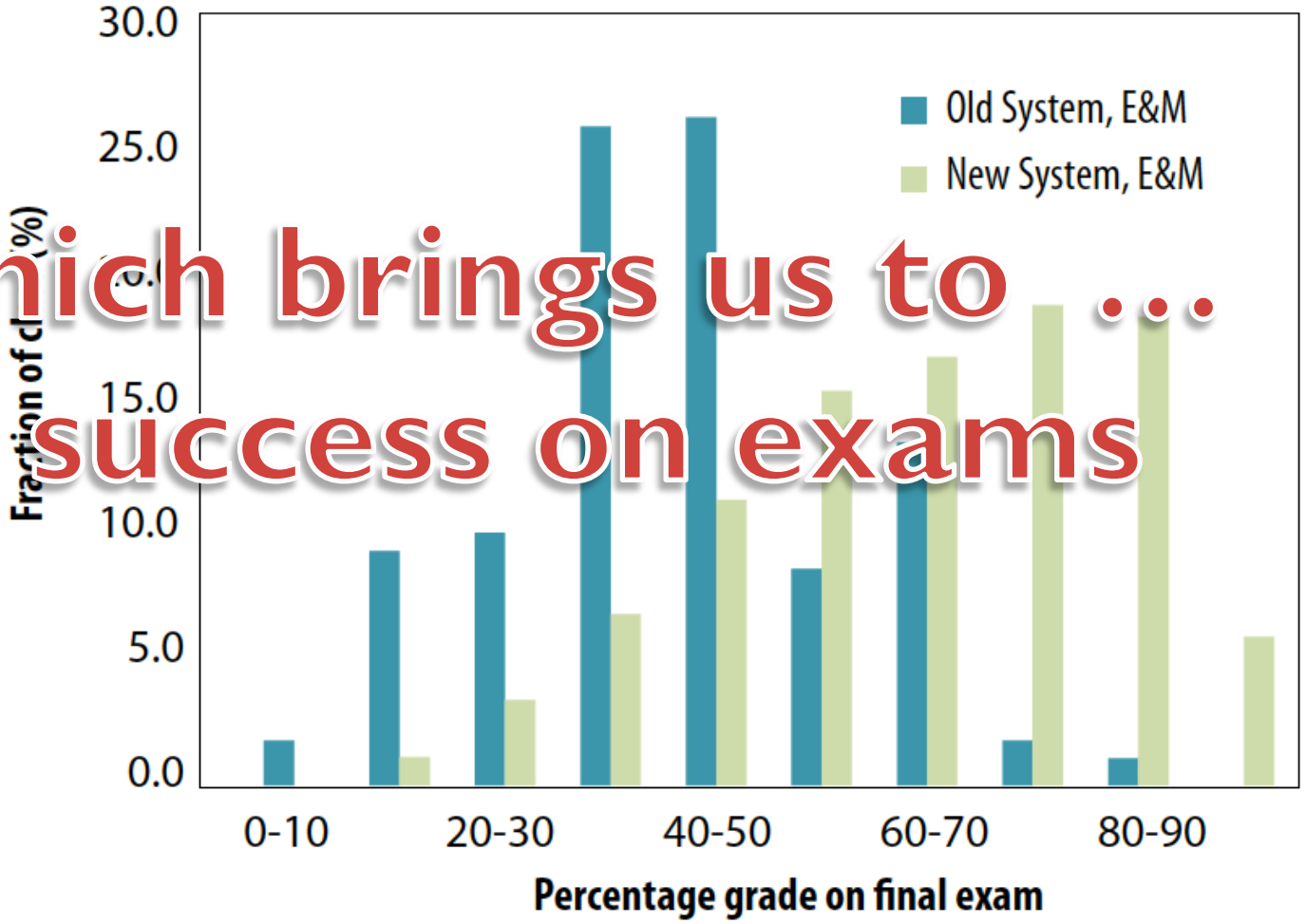


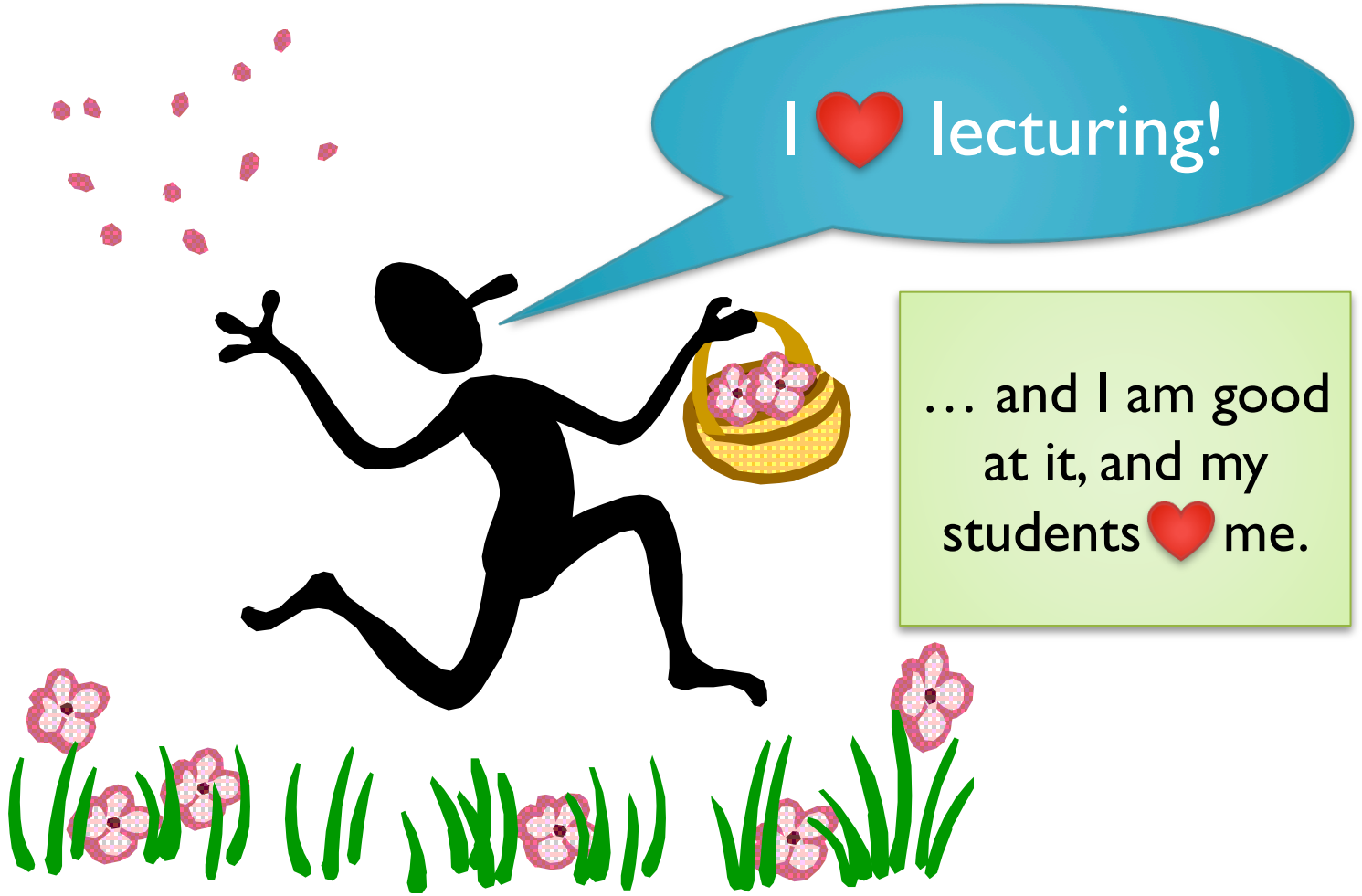
Which brings us to …

…success on exams

James T. Laverty, Wolfgang Bauer, Gerd Kortemeyer, and Gary Westfall, *Want to Reduce Guessing and Cheating While Making Students Happier? Give More Exams!*, The Physics Teacher **50**, 540-543 (2012)

No. 7: Traditional transmission lectures are …

- We like to hear ourselves talk, but …



No. 7: Traditional transmission lectures are …

- Early on, we gave the same or similar exams to traditional and online sections for several years
- Different instructors, different courses, different students, different entertainment value, different levels of German accent …

What do you think?

No. 7: Traditional transmission lectures are useless

- Early on, we gave the same or similar exams to traditional and online sections for several years
- Different instructors, different courses, different students, different entertainment value, different levels of German accent …
- **No significant difference** on exam performance between online and classroom

No. 7: Traditional transmission lectures are useless

- Both students and faculty might think that learning happens from lecturing, but it's neither better nor worse than reading materials online
  - Actually, both equally "bad"
  - Students don't always learn what we (and they) expect

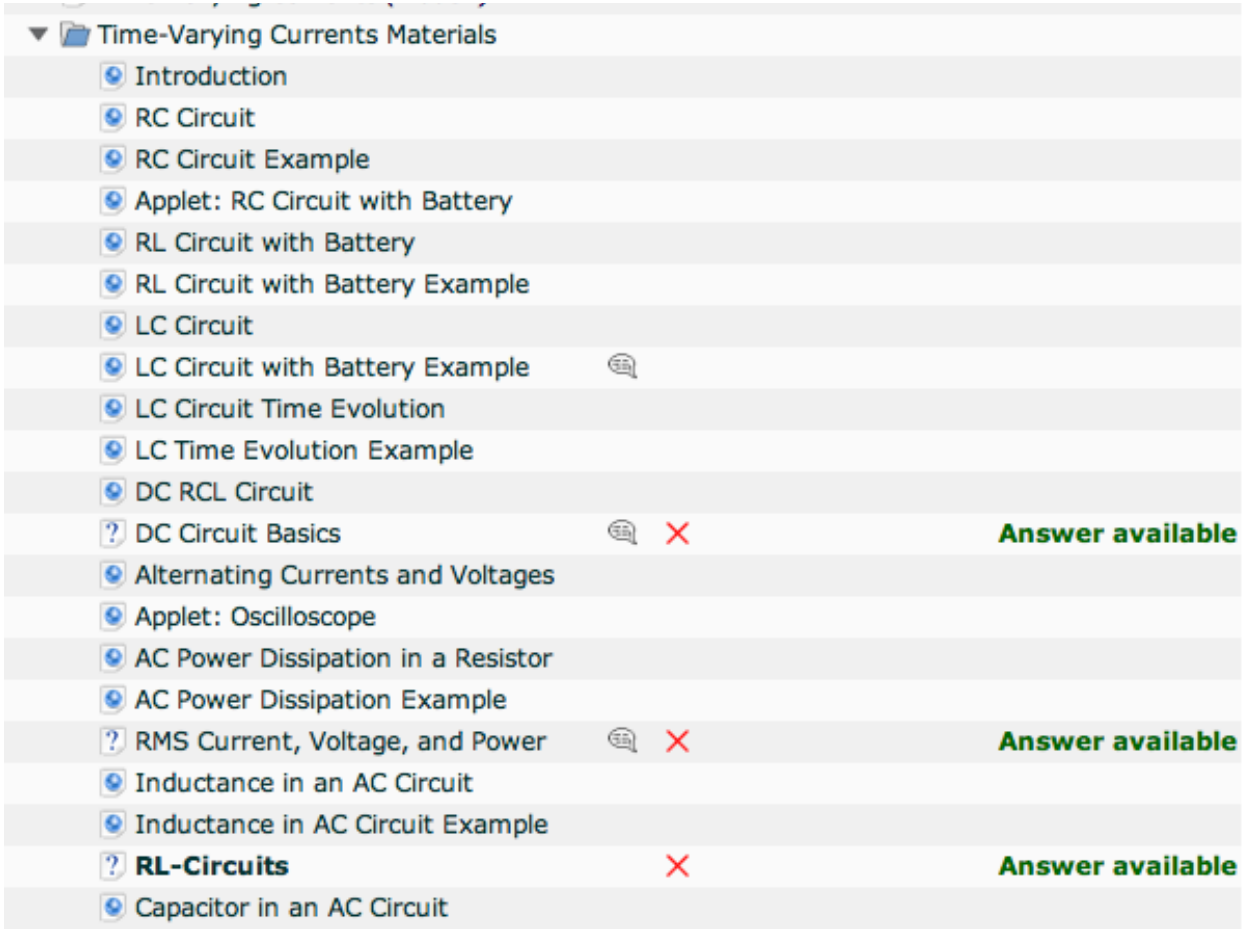
Now what?!

No. 8: Use traditional settings better

- If classroom is not better than online, then classroom is a waste of time
  - If content transmission (talking and demos) is all that the students get, they should move online instead
- Instead, just like with online, make use of the classroom "medium"
  - You have the students together in one room
    - Move content transmission to online reading
    - JiTT
    - Use lecture time for peer instruction and problem solving

No. 8: Use traditional settings better

- Reading questions due before lecture

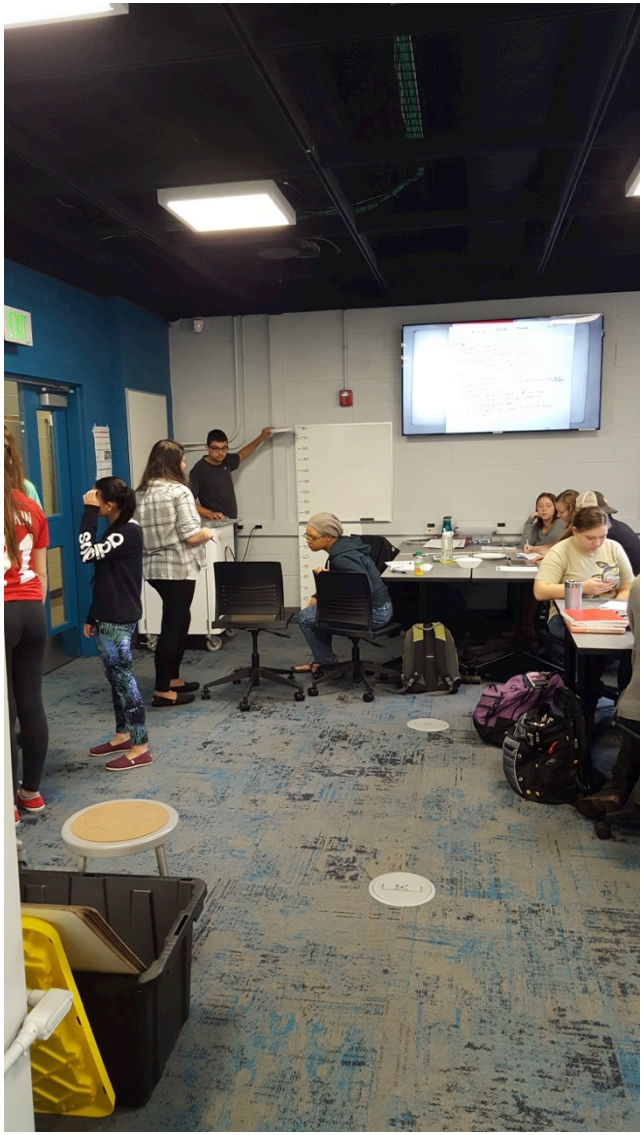


No. 8: Use traditional settings better

- If you don't like giving courses online, then make your traditional courses better!
  - Otherwise, there is no evidence for online being any worse
- So, that's what we do now at MSU
  - If students chose to spend time with you, make it worthwhile

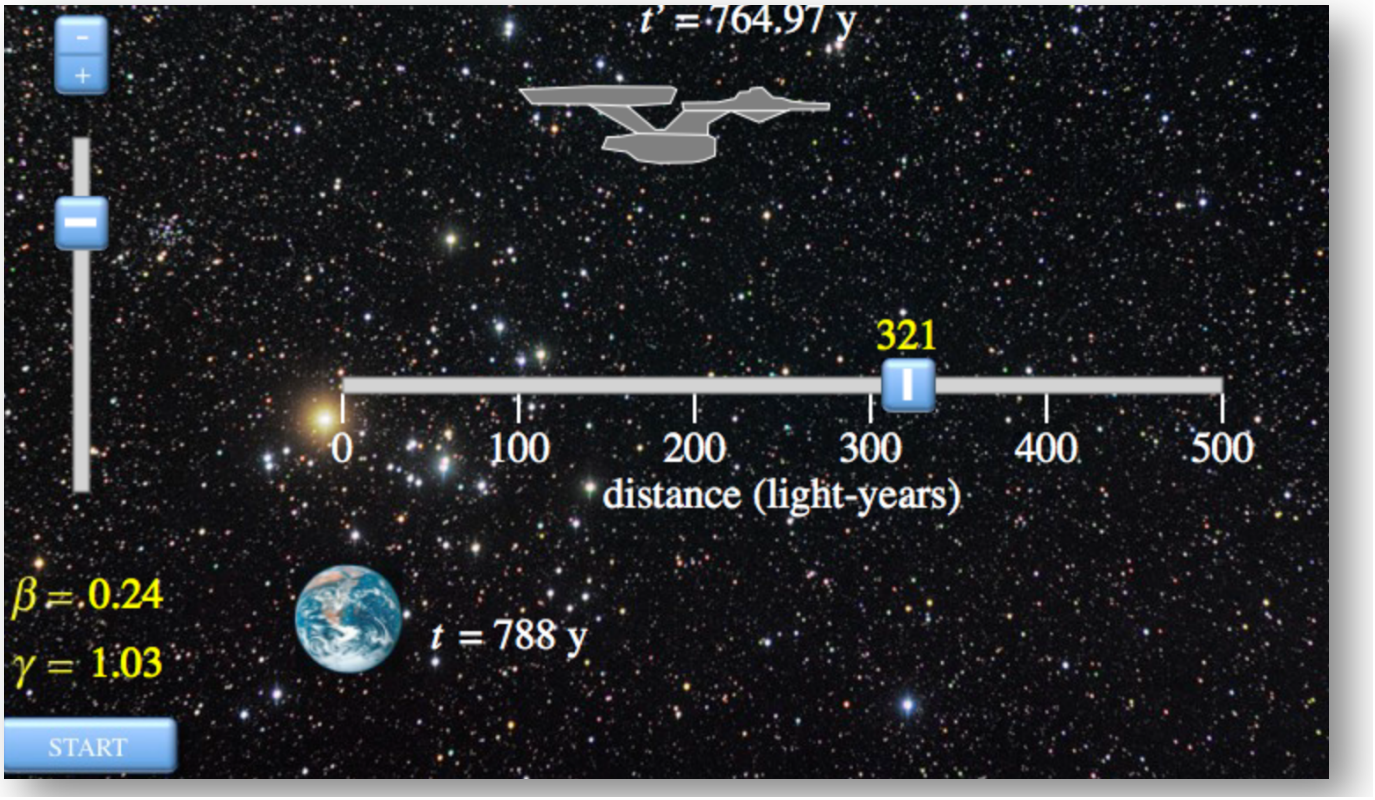
No. 8: Use traditional settings better

- Studio physics
- Just finished the first year
- We survived



No. 9: Demos and Labs are a Problem

- Early on: embedded elaborate videos of demos and simulations
- What do you think happened?



No. 9: Demos and Labs are a Problem

- Only a tiny fraction of students even looked at those
  - Fun for **us**
- Some course: simple "kitchen physics"
  - Had students do simple experiments with inclines and stop watches
  - Needed to upload photos and data
  - Worked, but only gets you so far

No. 9: Demos and Labs are a Problem

- Tried video analysis
  - Again, only works for kinematics
- Future (maybe): iOLab
  - Using in Studio physics now, work great

Thank you!

- Gerd Kortemeyer
  kortemey@msu.edu