From Lecture to Active Learning

Rewards for all, and is it really so difficult?

David Pengelley

Oregon State University
New Mexico State University
www.math.nmsu.edu/~davidp

Overview

- Thoughts about lecturing and classroom time
- Scientific evidence and reactions
- What is meant by “active learning”
- Alternatives (includes escaping the lecture/textbook trap!)
- Inertia
- Rewards
- Will this work?
- How much time does it take?
- Discussion

Lecturing Has Been Standard for 500 Years!

- Inspiration vs. Learning
  - Television
  - Videorecorded lectures
- "I understand perfectly when you lecture, but then I can't solve problems at home."

Learning Is Not a Spectator Sport!

I want my students to be

- Active in class ***and*** at home
- *DOING* [mathematics]
- Exploring and finding their own multiple ways to solve problems
- Creative and having fun
- Experimenting, conjecturing, proving, and generalizing

Classroom Time Is Precious

Do you want your students to spend it on

- First contact with new material

OR

- Higher level activity?

Evidence

- S. Freeman et al, Active learning increases student performance in science, engineering, and mathematics, *Proceedings of the National Academy of Sciences 111* (2014)
- Meta-analysis of 225 studies of undergraduate education across all STEM areas

Evidence

- Active learning improves grades, reduces failure among undergraduates in STEM areas
- 55 percent more students fail lecture-based courses than classes with at least some active learning

Recent Reactions

- National Science Foundation press release (2014): "Enough with the lecturing"
- "Active learning": Reduce or eliminate lecture, and devote substantial classroom time to student involvement in work that receives immediate feedback from other students and from the instructor.

Alternatives?

- My conclusion (evolution starting 25 years ago): Lecture is the least effective means of teaching
- Inefficient
- Obsolete (video)

Alternatives?

We underestimate our students' abilities: Our job is to challenge in the right ways, to achieve potential.

Inertia

- I-(We)-You
- We teach as we were taught (but we weren't typical, largely self-taught)
- Both instructors and students are extremely comfortable with lecture
- "How could I cover the material in the syllabus if I didn't lecture?" Trapped!
- We are not responsive to scientific evidence
- It takes effort to change (more work first time)
- Motivated more by personal reward, interest

Rewards for All

- Higher quality interactions with students; more rewarding in class
- Fewer exams to grade
- Less need for office hour time
- More rewarding homework marking
- No more time spent by me overall
- Syllabus less rushed; more coverage: students cover versus instructor covers; reduce cram-exam-forget; more even workload; less stress for all; avoid burnout
- Student responses

Case Studies

- 20 year evolution, started in Calculus I, II
- MATH 191,192,210,275,279,291,331, 332,411,430,452,453,455,459,541, 542,561
- Materials: Textbooks, projects, primary historical sources

Alternatives to lecture

- "Flipped/inverted classroom"?: video lecture, in-class group work (worksheets)?
- But still may be passive; still must make lectures and/or worksheets; still some first contact in class
- Instead: Eliminate lecture, replace with active student preparation for class

Alternatives to lecture

Goal:

1. Students read, and write responses
2. Students do preparatory work before class
3. In-class, group work and presentations build on top of preparation
4. Post-class harder homework, higher level

I-(We)-You → You-You-Y'all-We-You

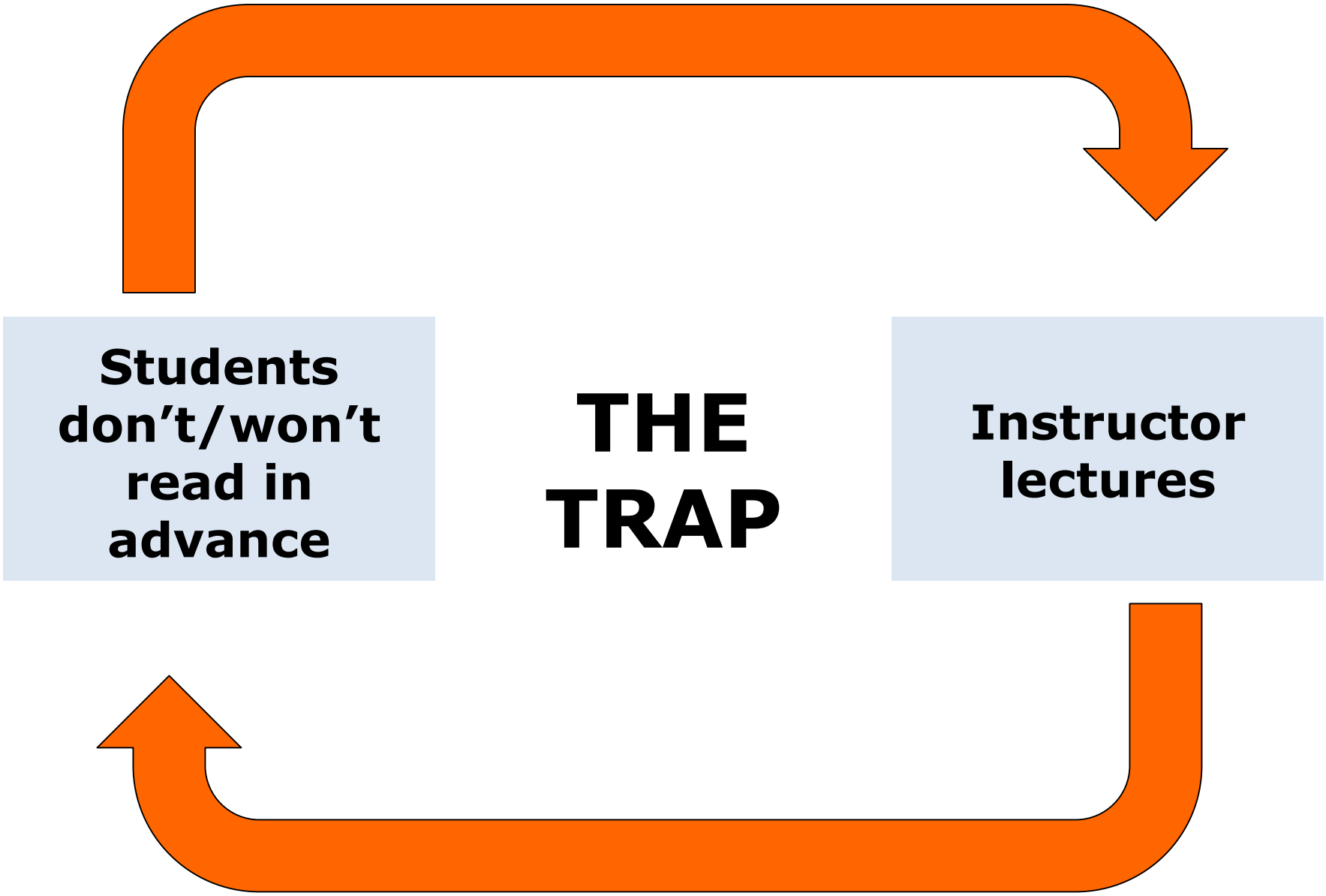
Alternatives to lecture

HW A,B,C rolling assignments

- A: Read, write responses to my questions for l.d. courses, write questions for l.d./u.d.; I read, mark quick +,✓,-, to prepare for class
- B: Prepare warm-up problems
- In-class: Briefly discuss reading responses; Gp. work on warm-ups, present, discuss. Hand in B: quick +,✓,-
- C: Post-class, a very few harder problems: grade A-F (*no points*)

Questions: Will this work?

Will students really read and write in preparation for class?


Students don't/won't read in advance
THE TRAP
Instructor lectures

Questions: Will this work?

- Will students really read and write in preparation for class?
- Students *will* read/write, hand it in. Part of grade; see value, become enthusiastic about it
- *Motto*: Never lecture on material students can read.

Questions: Will this work?

- Will students prepare warm-up problems before class?
- *Yes.* Part of grade, day one, peer and instructor pressure, presentations, see value
- Parts A,B,C *must* be a very large part of course grade (≥60%); *less* examining
- Harmony between learning and evaluation

Logistics

Homework parts are *assigned* in rolling trios

(*Described in more detail on my website*)

Day 4	•	•	**5A**				
Day 5		•	**5B**	**6A**			
Day 6			**5C**	**6B**	**7A**		
Day 7				**6C**	**7B**	•	
Day 8					**7C**	•	•

From Lecture to Active Learning

Rewards for all, and is it really so difficult?

David Pengelley

Oregon State University
New Mexico State University
www.math.nmsu.edu/~davidp