Australian National University

How to teach people astrophysics so that they still remember it more than a week after the end of their last exam

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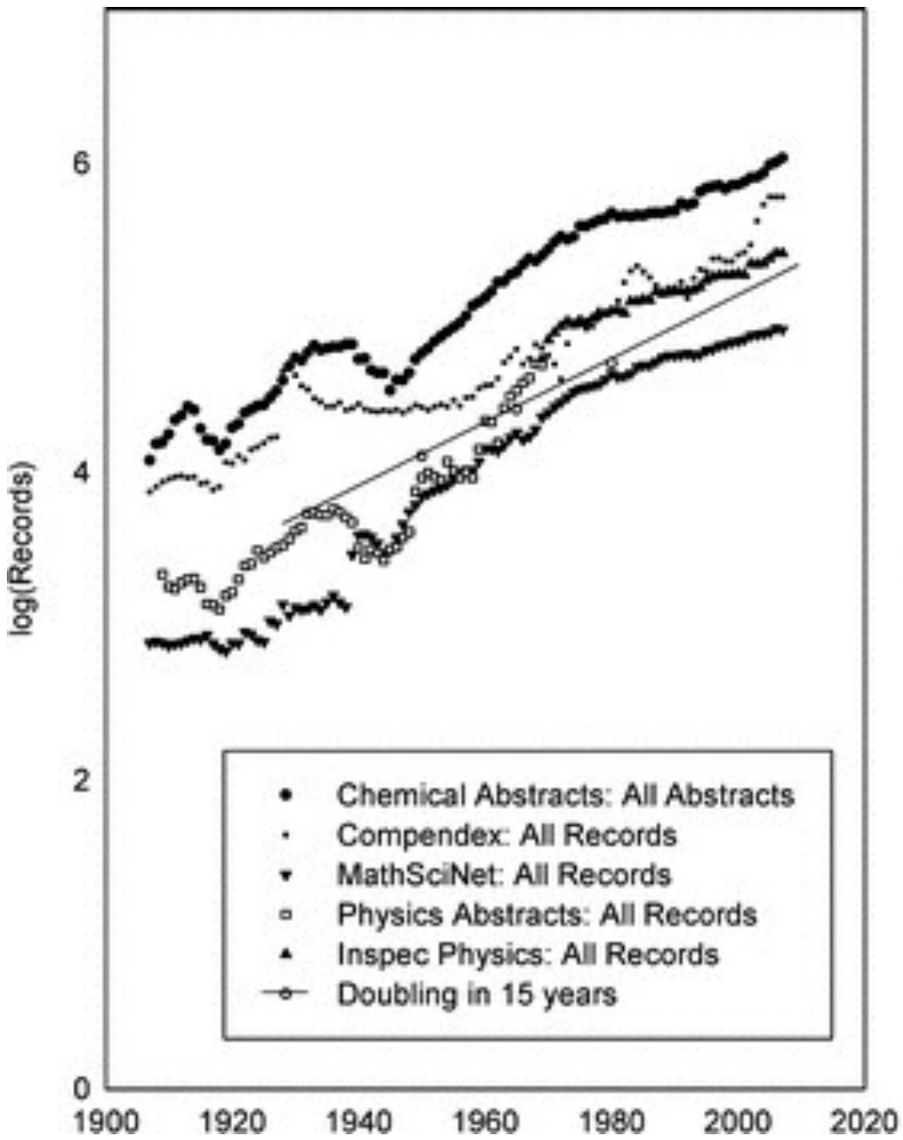
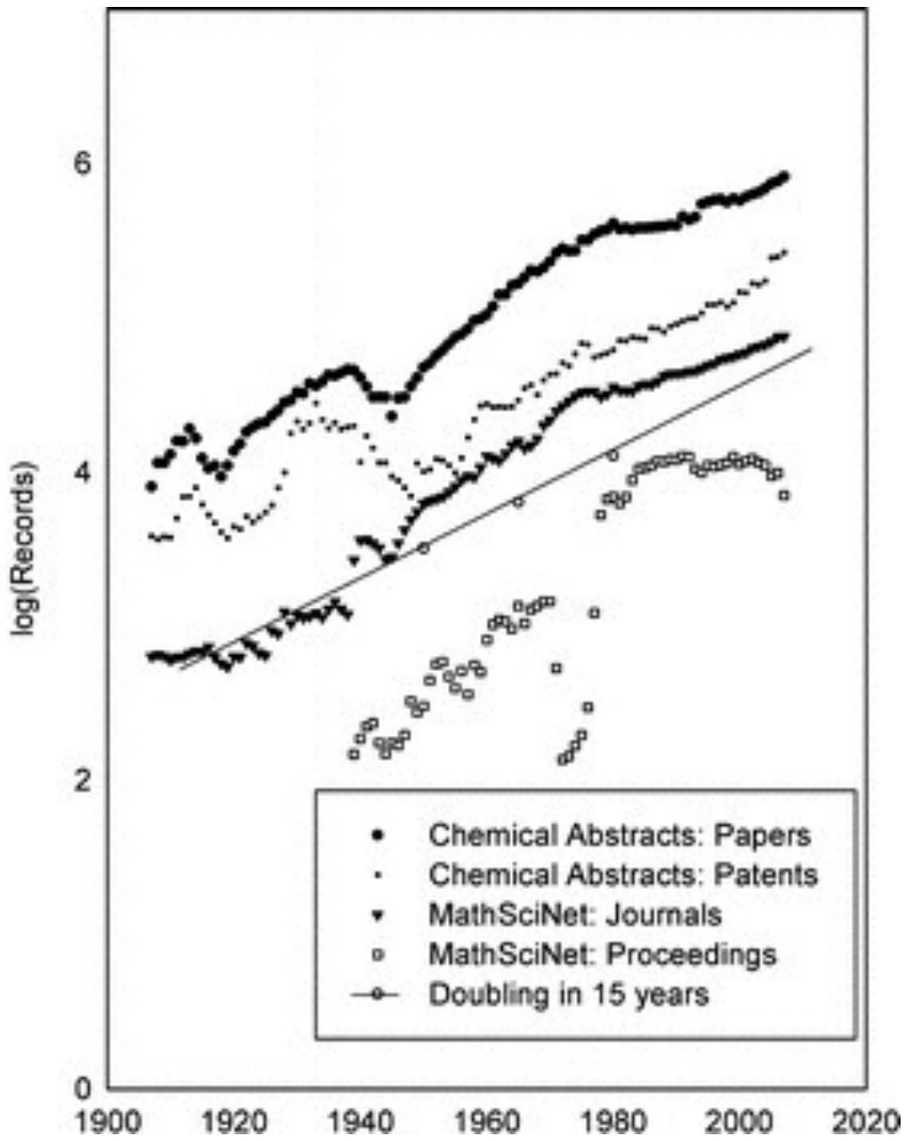
Many of you will go into university teaching

- Many are probably doing it now.
- But is it a critical problem?

The amount of knowledge doubles every ~ 15 years





So if a physics degree took three years in 1900...

- Learning things with the same thoroughness today would take 507 years.
- Unless... we can teach it better.

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But despite big increases in spending, how much students are learning isn't increasing

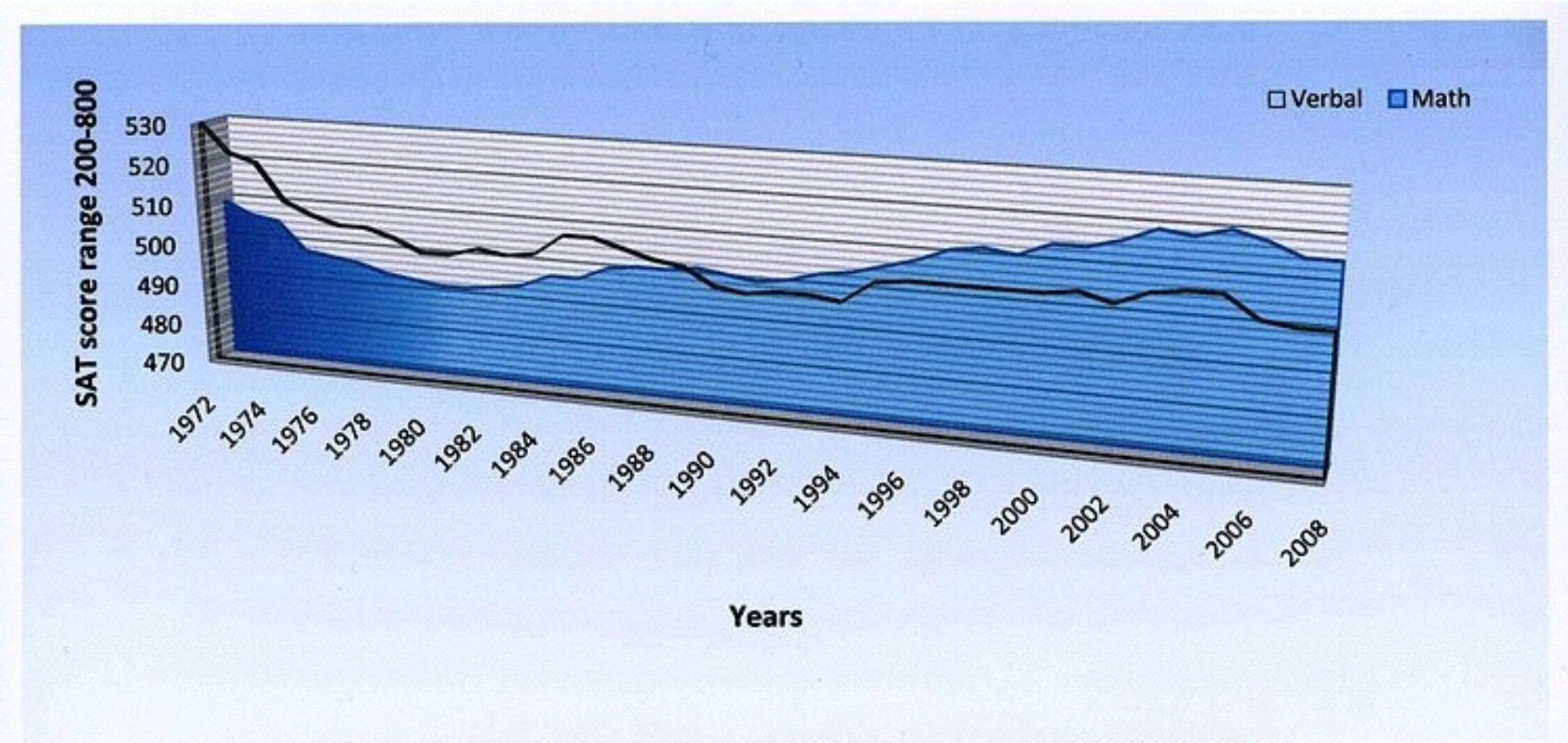
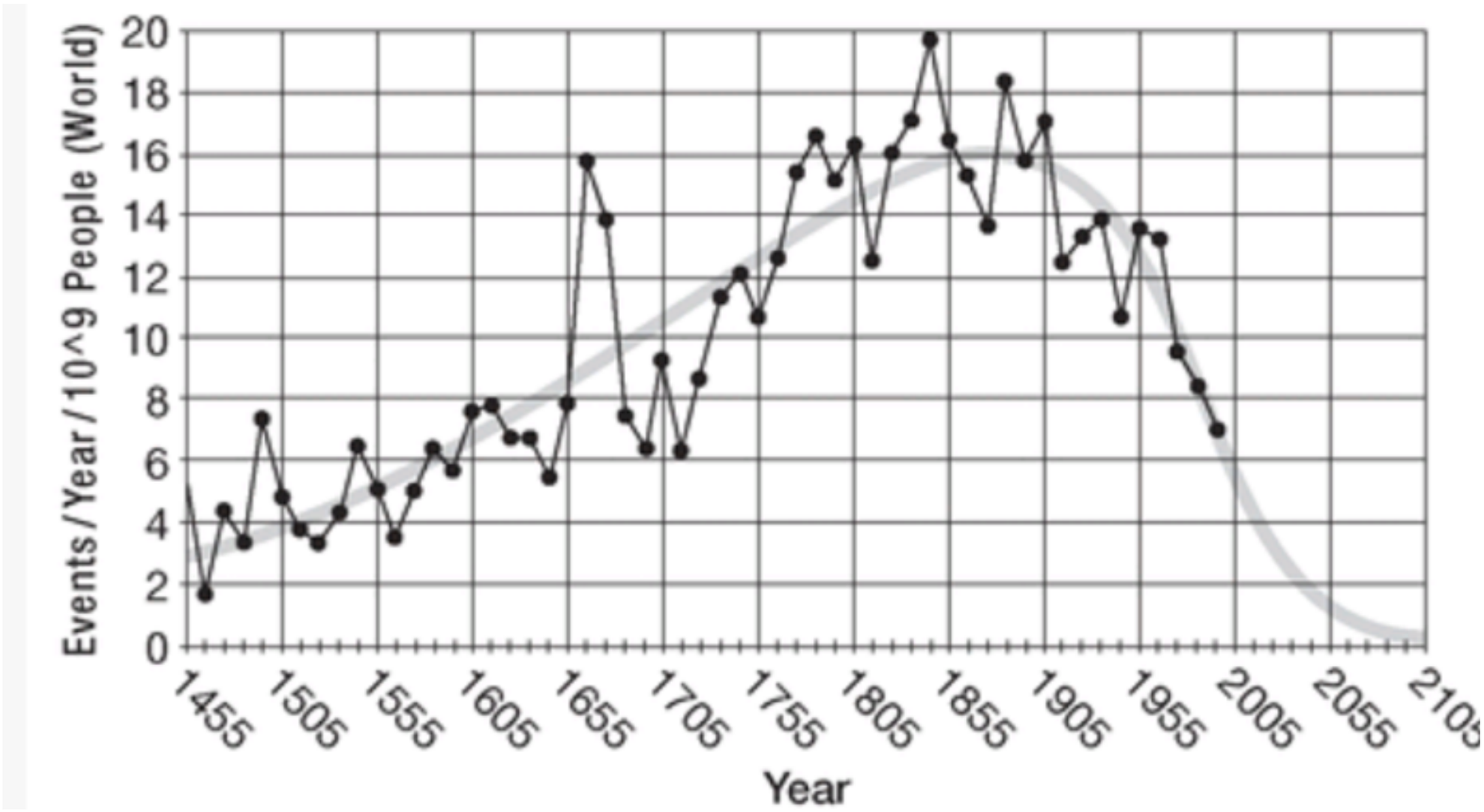


Figure 1. Chronology of U.S. math and verbal averages on the SAT: 1972-2008

Net result, increasing specialization

- Arguably this is slowing scientific progress



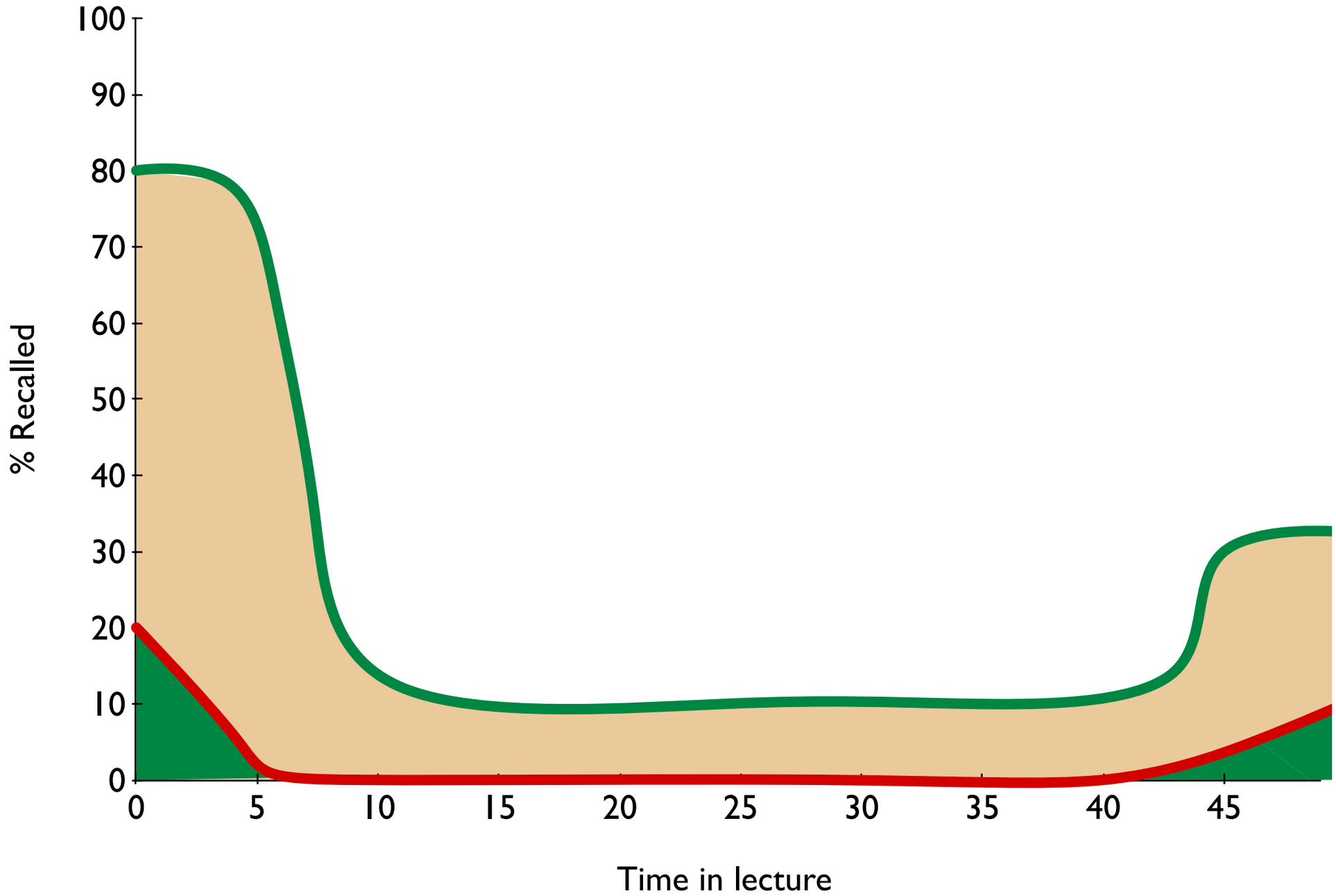
So is it possible to get knowledge into heads faster?

- And if so, how much faster?
- Or is there some fundamental limit to how fast knowledge can be inserted into heads?

What's the problem?

- Low recall?
- Misconceptions?
- Plug and chug?
- Teaching the wrong stuff?
- Transfer

How much you remember?



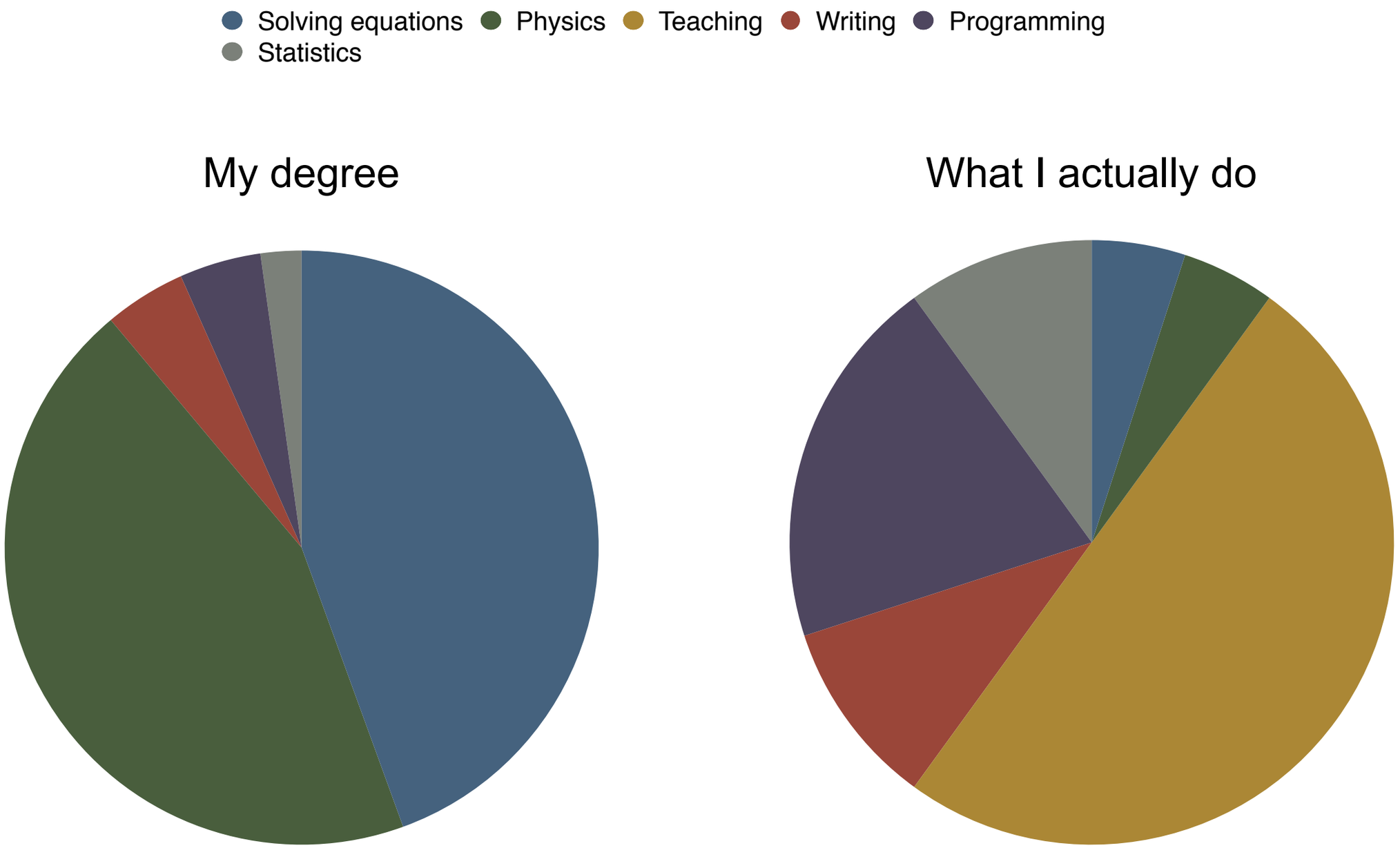
Misconceptions

- If you throw a ball across a room...
- What forces are acting on it as it flies through the air?

Plug and Chug

- Rote-learn every possible equation
- Use key-word recognition or timetabling to work out which equation to use.
- Do algebra, plug in numbers.

Are we teaching the right things?

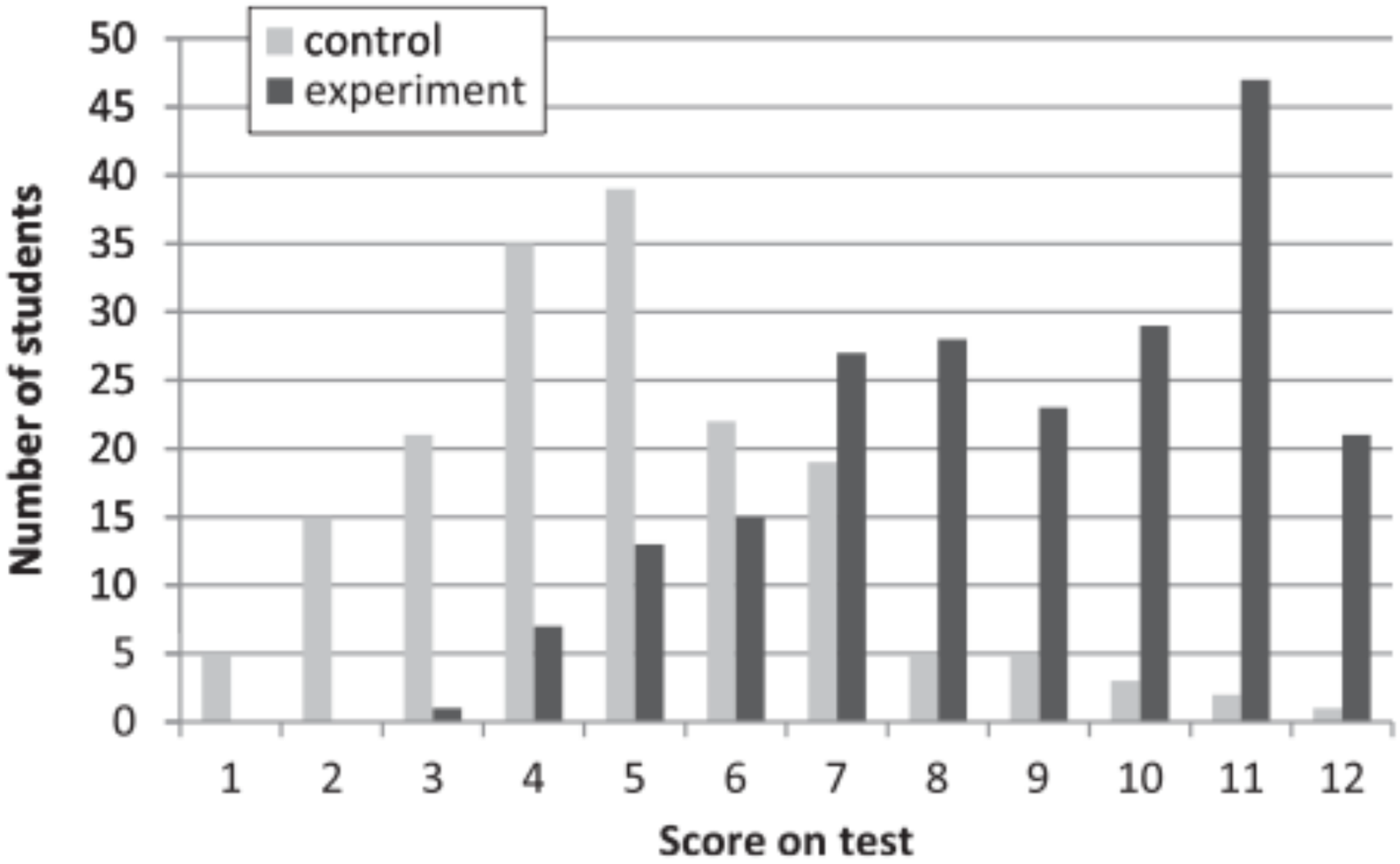


Conventional wisdom amongst economists

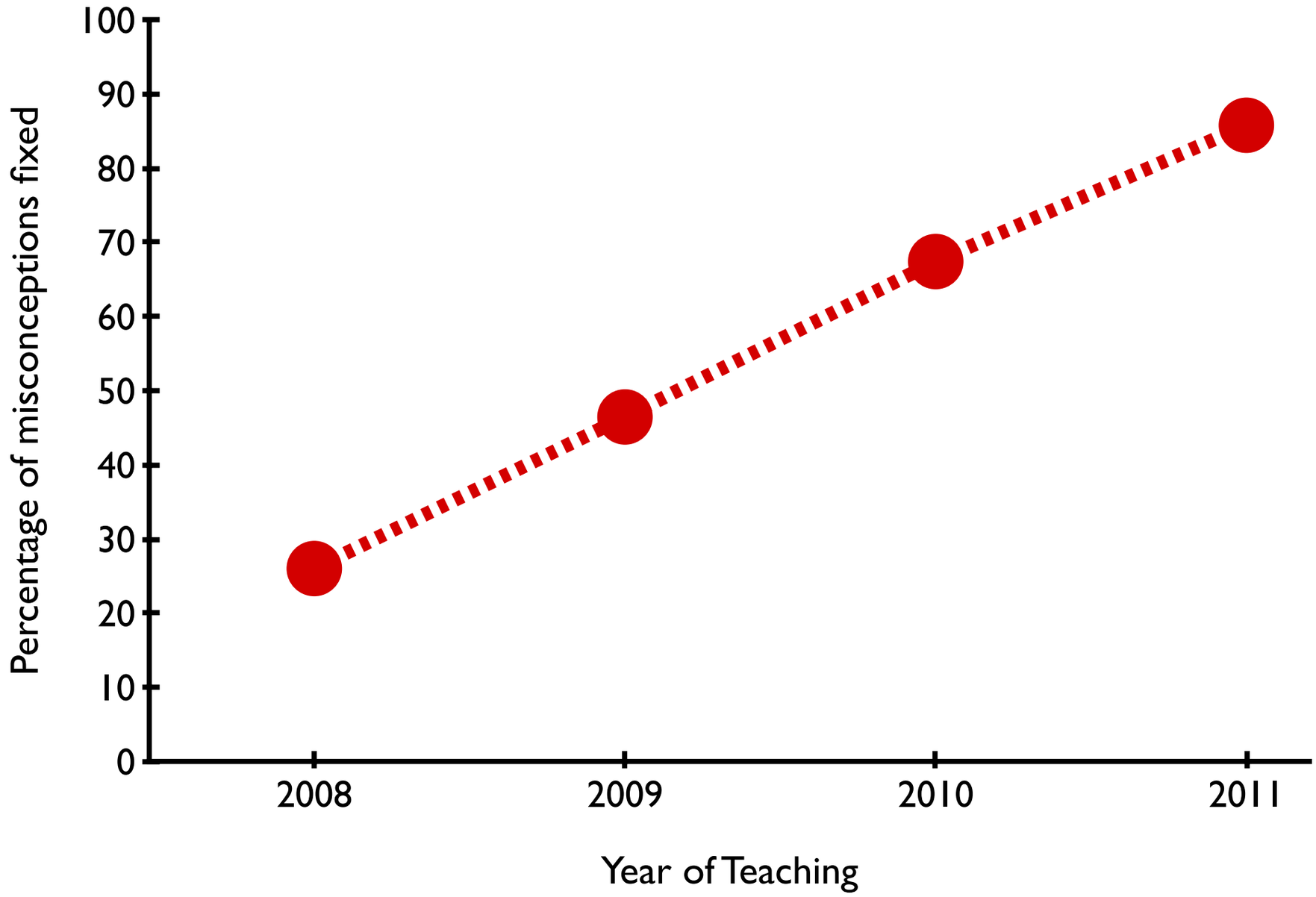
- Nobody learns anything useful.
- Higher education is about "signalling" and "credentialism"

Can we do better?

- Yes, so it seems



Force Concept Inventory Gain



What works?

- Active not passive
- Know your goals
- Social, not solitary
- Student centred
- Deliberative practice and cognitive load
- **Experimental with short feedback cycles**

Clickers

Deliberative practice

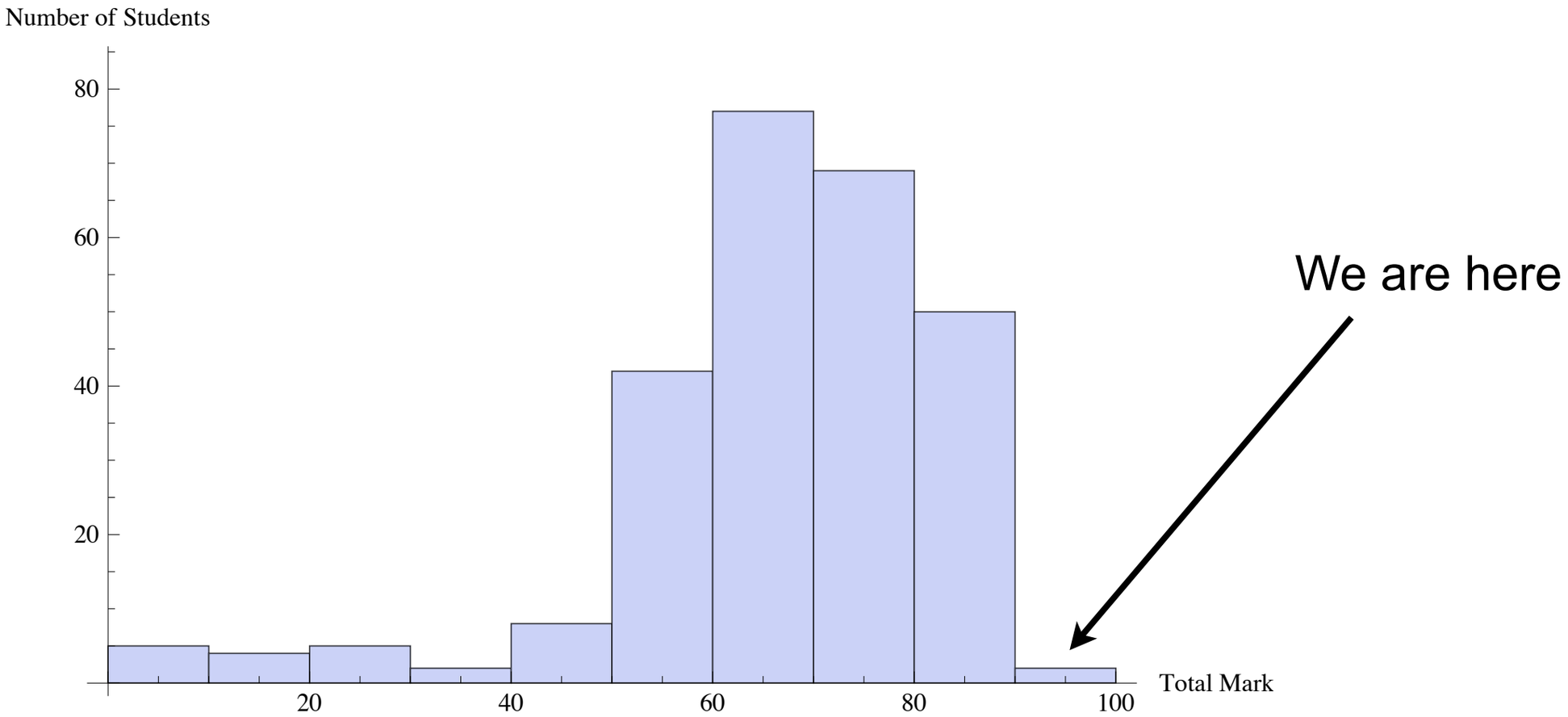
- Research into real expert sports-people, chess players, scientists, doctors, musicians etc reveals that the real secret of elite performance is around 10,000 hours of “Deliberative Practice”
- Very intense practice, constantly varying your approach, with instant feedback.

Cognitive Load Theory

- What's hard about physics?
- Working memory
- Need to automate basic tasks

Most important of all

- Keep an experimental, trial-and-error approach.
- They are not like us
- All educational theory is suspect due to publication bias



Conclusions

- I don’t know the answer - how fast people can be taught.
- I suspect that it is a factor of ~3 faster than we currently achieve.
- The situation is so complex that trial and (lots of) error is the only way to figure this out.