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

![Graph showing the percentage of recalled information over time in a lecture. The graph indicates a sharp decline in recall immediately after the lecture, followed by a slow recovery over the next 45 minutes.](image)
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?

My degree

What I actually do

Solving equations  Physics  Teaching  Writing  Programming
Statistics
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

![Graph showing percentage of misconceptions fixed over years of teaching (2008-2011).]
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.