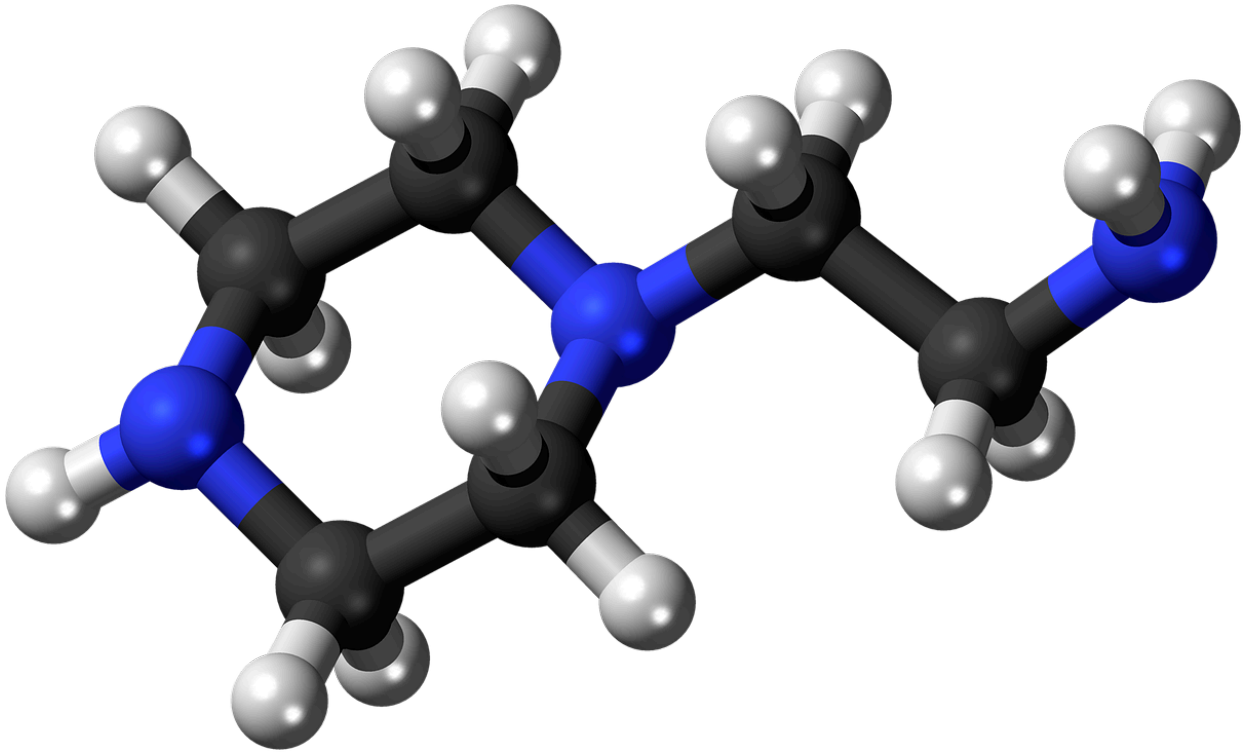
Novices and Formative Assessment

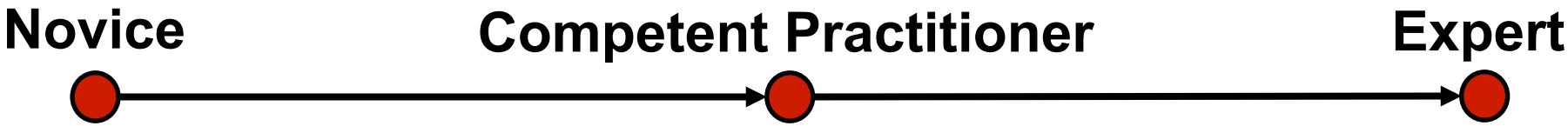
Cognitive Development and Mental Models

- What is a mental model?



How to Characterise Skill?

- Differences in skill = different mental model
- Dreyfus model of skill acquisition simplified:



Doesn't know what they don't know – no *mental model* of domain

Reason by analogy and guesswork

Borrow from other mental models that seem similar

Good mental model for everyday purposes, e.g. driver and car

Model perhaps not completely accurate

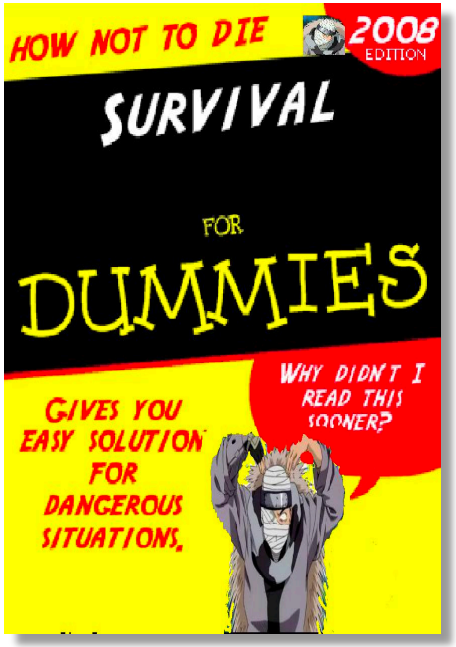
Can do normal tasks with normal effort under normal circumstances

Can handle out of the ordinary situations

Diagnose problem causes

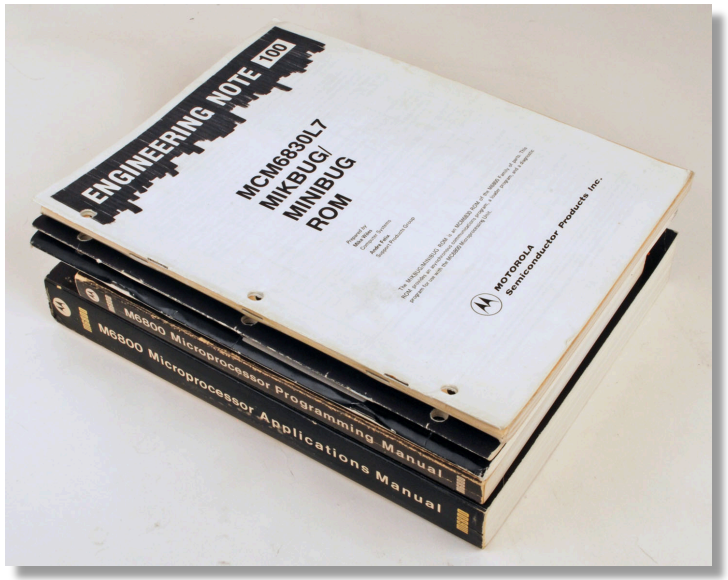
Tutorial vs Manual

- Novices, competent practitioners, experts need to be taught *differently*



Tutorial

vs



Reference Manual

Tutorial vs Manual

Tutorial

Narrative

Practical

End goals

Trivial cases

Works progressively

Doesn't assume prior knowledge

Interactive

Explains not just describes

Manual

Generic

Comprehensive

Detailed

Easy to find information

Technical language

Cross-references

Non-linear

Machine generated

Dull, boring!

Assume Carpentry learners are Novices

5-15% use GPU clusters to analyze petabytes in the cloud

85-95% send each other spreadsheets by email

- Easy to overload novices with too many facts
  - Unix shell lesson – 15 commands in 3 hours!
- Help them develop a *working mental model*

Building Useful Mental Models

"It ain't what you don't know that gets you into trouble, it's what you know for sure that just ain't so" – Mark Twain

- Clearing up learners misconceptions
  - **Simple factual errors** – easy to correct, but not enough
  - **Broken models** – correct by reasoning, address contradictions ***Our focus!***
  - **Fundamental beliefs** – e.g. "world is only a few thousand years old", can't really address these

What happens next?

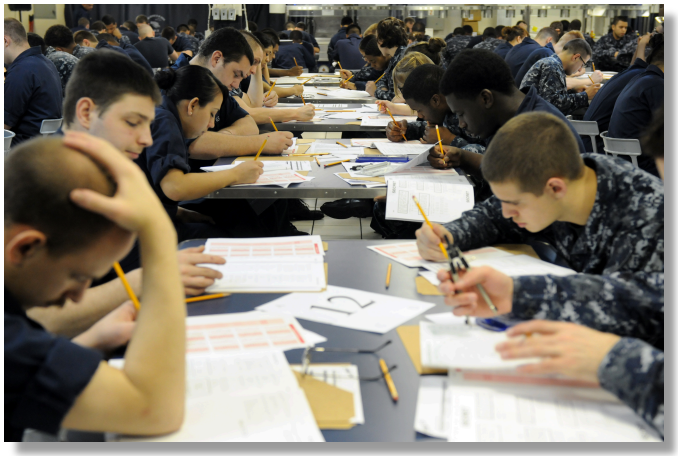
- Example of correcting a broken mental model

- Place block of ice in a bathtub, fill tub to brim with water
- When ice melts, does the water level:
  1. Go up (overflowing the tub)
  2. Go down
  3. Stay the same?

Assessing Mental Models

- Need to expose the broken mental models

Summative Assessment



Did desired learning take place?
Can learner move on?
Pass or fail

Formative Assessment

Guide learning by informing instructor and learner what to focus on
No pass or fail

Our focus!

Multiple Choice Questions

- Formative assessment needs to be quick to administer and evaluate – e.g. MCQs

Q: what is 27 + 15?

a) 42
b) 32 *Throwing away carry completely*
c) 312 *Carried '1' is actually a ten to be added*
d) 33 *Carrying '1' by adding to wrong column*

Applying MCQs

1. Teach some stuff
2. Present MCQ probing for misconceptions
3. Students vote on MCQ answers
   - Mostly all right answers, move on
   - Mostly all same wrong answer, address misconception
   - Mix of right and wrong, rewind to previous point, or get them to discuss

- Recommend every 15 mins or so – break up session
- Can use preemptively!

Exercise

Create *multiple choice question related to topic you intend to teach*

Explain *diagnostic power of each distractor, i.e. what misconception is each distractor meant to identify? A sentence for each is fine*

Pair *up with your neighbor and discuss your MCQs, providing feedback*

Place answers in Google Doc:

- *http://bit.ly/ITOxfordMar*

Notes on MCQs

- A good MCQ tests for conceptual misunderstanding, not facts
- For distractors, think about problems from previous training events
- MCQs are useful even if not used!