How People Learn--Implications for teachers and students.

I) Introduction

II) What research tells us about expert thinking and the effectiveness of different teaching approaches?

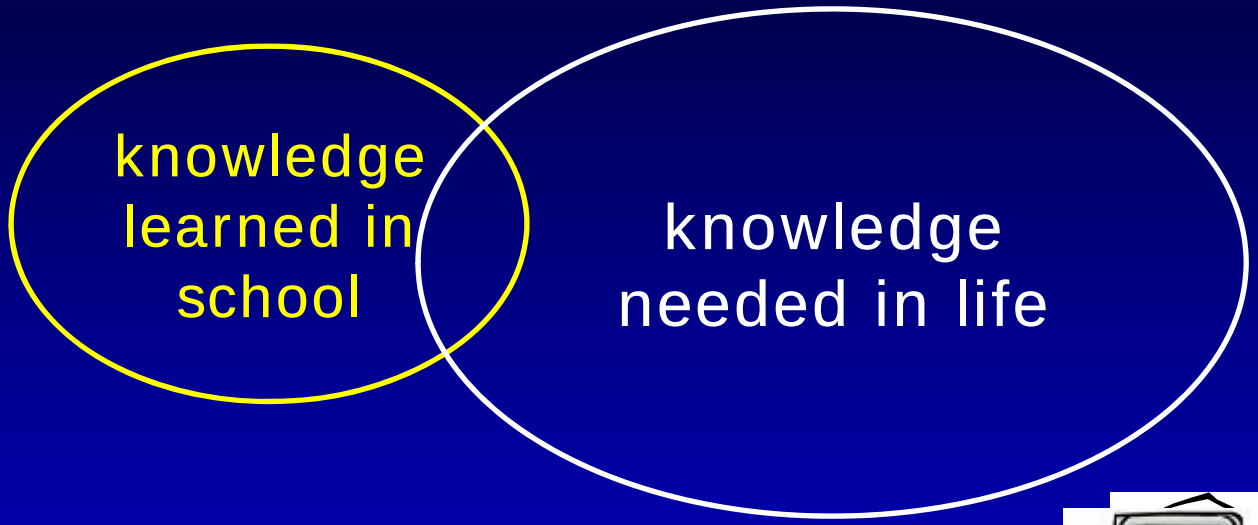
III) How research can be used to help you teach/learn better.

a. principles for achieving learning

b. implementing the principles

Meaningful learning in age of Google?

Information incredibly accessible!



If learning/teaching just facts.

Learning that matters--
Analyze, design & create, solve complex problems, communicate--- "think"

How best to teach/learn this?

People have always had strong opinions on learning and teaching

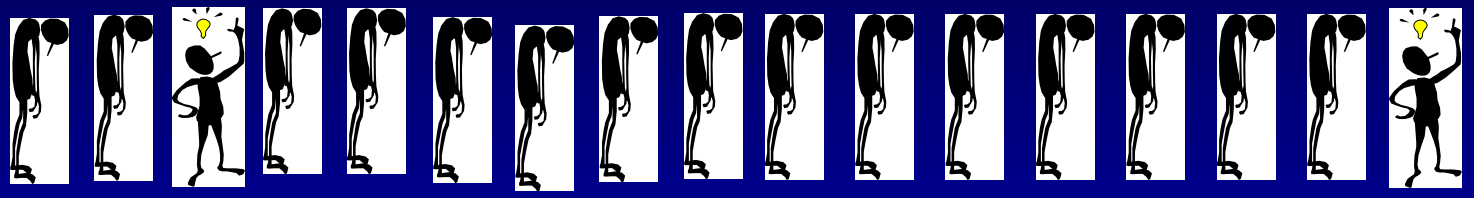
many come and go, two always stay

1. "Today's students are lazier, less prepared, and stupider than my generation!"
   sentiments well documented 2008 AD $\Rightarrow$ 450 BC ...

2. Best way to teach/learn.
   a. Expert gets subject very clear in their own mind.
   b. Explains to students and they will think same.

2. Best way to teach/learn-- an expert telling.

my students after superb explanations



??

Last 15 years studying learning.

Major advances past few decades
Consistent picture ⇒ Achieving learning

classroom studies

brain research

cognitive psychology

Systematic ways to measure learning (= teaching effectiveness). Consistent patterns.

⇒What works? What doesn't? Why?

opinions
evidence!

II) Research on learning & teaching

A. How experts think and learn.

B. Classroom research. Traditional science teaching. How well teaches expert thinking?

III) How this research can be used to help you teach/learn better.

Some Data:

Data today mostly from science, ideas general

traditional lecture method | **research-based teaching**

- Retention of information from lecture

  10% after 15 minutes ⇒ **>90 % after 2 days**

- Fraction of concepts mastered in course

  15-25% ⇒ **50-70% with retention**

- Beliefs about science-- what it is, how to learn, how to solve problems, interest

  significantly less (5-10%) **like expert** ⇒ **more like expert**

Expert competence research*

(historians, chess players, doctors, violinists, scientists, ...)

Expert competence =

- factual knowledge
- **Organizational framework** ⇒ effective retrieval and use of facts

or ?

patterns, associations, connections-- scientific concepts

- **Ability to monitor own thinking and learning**

("Do I understand this? How can I check?")

New ways of thinking-- require MANY hours of intense effort. Change brain "wiring"

*Cambridge Handbook on Expertise and Expert Performance

Developing Expert Competence

Many hours "effortful study"*

"Effortful study" :

1. Challenging tasks/questions requiring expert thinking

2. Barely doable-- demands full concentration/effort
   (less time + more quality = better learning)

3. Feedback & reflection
   ⇒ guidance on thinking & learning

take-home lesson

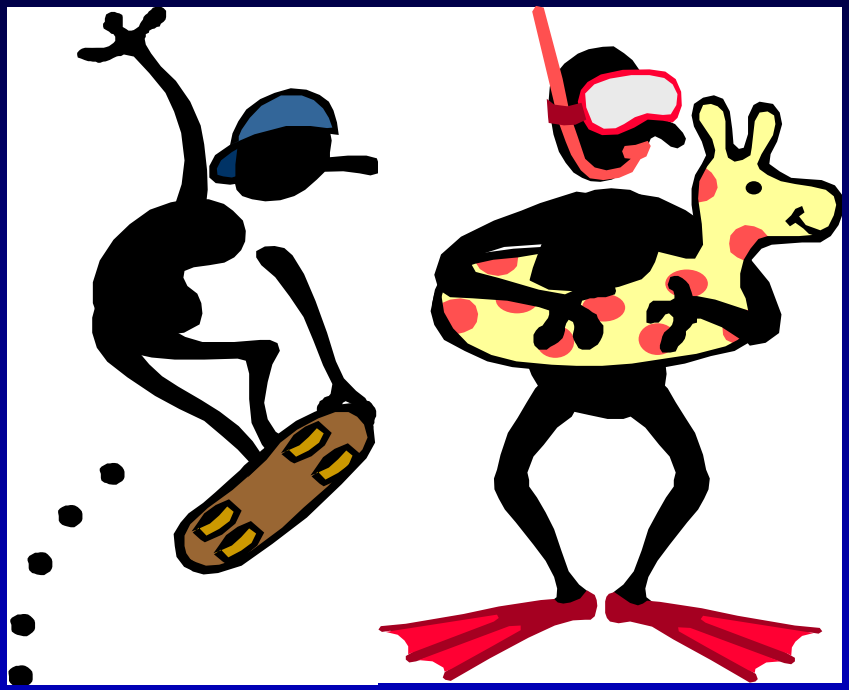
* A. Ericsson, Cam. H. Expertise...

How experts learn--
(including from lecture)

Continually actively processing new information
Questioning
Testing
Reconciling
Reflecting

Expert-like learning from this lecture
Testing against prior knowledge-
Makes sense? Where connects, extends, or conflicts?
Adjustments to my thinking warranted?
Where and when ideas apply? Generalize?

Meaningful Education = transform how think--



Think about and use subject (more) like expert. (scientist, historian, nurse, ...)

⇒ University Classroom Research

How well are students learning expert-like thinking from traditional teaching? (lectures & exams)
(Data from science)

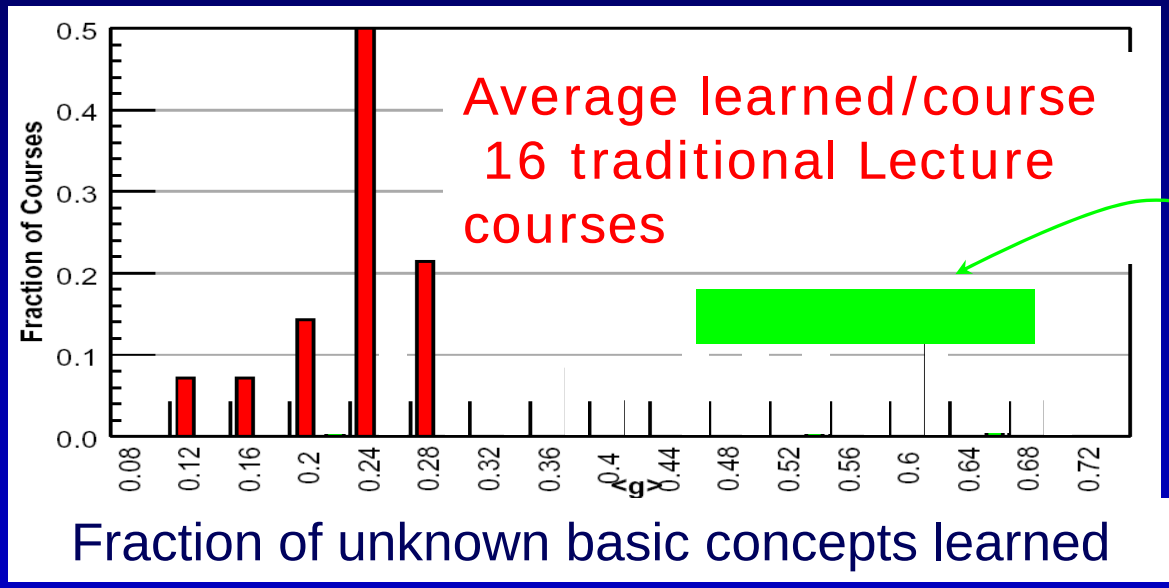
1. Conceptual understanding.

2. Beliefs about the subject
   what and how to learn

1. Mastery of general concepts

• Study student reasoning - basic concepts of force and motion ⇒ good test for measuring, simple applications.

Ask at start and end of semester--
What % learned? (100's of courses)



"expert" practice with coaching

On average learn <30% of concepts did not already know.
Lecturer quality, class size, institution,...doesn't matter!
Similar data for conceptual learning in other subjects.

R. Hake, "…A six-thousand-student survey…" AJP 66, 64-74 ('98).

Data 2. Beliefs about physics/chem and learning

Novice	Expert
Content: isolated pieces of information to be memorized.	Content: coherent structure of concepts.
Handed down by an authority. Unrelated to world.	Describes nature, established by experiment.
Problem solving: pattern matching to memorized recipes.	Prob. Solving: Systematic concept-based strategies. Widely applicable.

~10% 

% shift?

intro physics & chem courses ⇒ *more* novice

ref.s Redish et al, CU work--Adams, Perkins, MD, NF, SP, CW

*adapted from D. Hammer

Why results so bad?

1) Learning as information transfer, not brain development.

2) Differences in perception. 3) Working memory limits.

2. Perceptions

Expert-- presenting information and problem solutions. Relevance & conceptual foundation obvious.

"curse of knowledge"

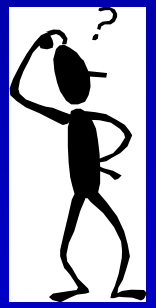
Novices-- no mental framework or context

"disembodied knowledge"

Exams define "learning"

Reinforces "learning" as memorizing facts and recipes.

Never practice expert thinking (or realize should).



3. Limits on working memory

Mr Anderson, May I be excused?
My brain is full.

Working memory capacity
VERY LIMITED!
(remember & process
< 4-7 distinct new items)

MUCH less than in typical lecture
⇒ retain small fraction

Summary--

Traditional science teaching poor at developing expert thinking.

Reasons clear.

$\Rightarrow$ how to do better

III. Essentials for learning research⇒ principles

from expertise development-- but match results from 1) educ. pysch., 2) science classrooms, 3) highly effective tutors, 4) brain research

1. Build on/connect with prior thinking
2. Explicit modeling and practice of expert thinking. extended & strenuous *(brain like muscle)*
    a. engagement
    b. effective feedback (timely and specific)
3. Motivation
4. Reduce unnecessary demands on working memory

---

from other research

5. Retention-- spaced repeated retrieval. Connections.

take-home lesson

III. Essentials for learning

Implementing in University courses

1. Build on/connect with prior thinking

*2. Explicit modeling and practice of expert thinking.
extended & strenuous *(brain like muscle)*
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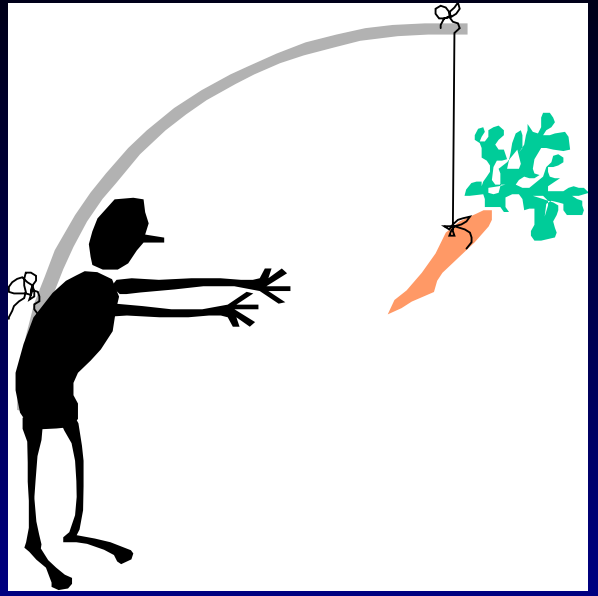
? 5. Retention-- spaced repeated retrieval. Connections.

Motivation-- a few findings

(complex-- dependent on previous experiences, ...)

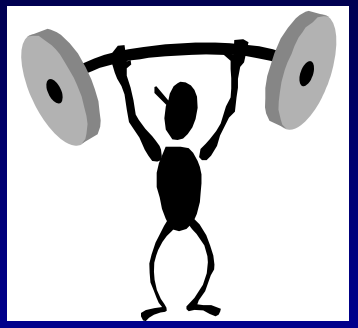


a. Relevance/usefulness to learner (meaningful context)

b. Sense that **can** master subject and **how** to master ("effortful study" in subject)

c. Sense of personal control/choice

Practicing expert-like thinking-- engaging, monitoring, & guiding



Challenging but doable tasks/questions.

Explicit focus on expert-like thinking

- concepts
- exploring relationships and associations
- sorting relevant & irrelevant information
- self-checking/sense making
- reflection on learning, ...

take-home lesson

Practicing expert-like thinking, monitoring, & guiding.

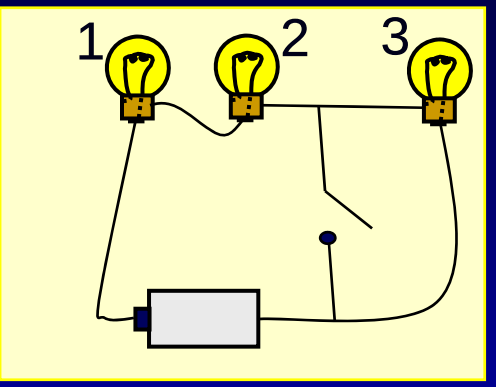
5-300 students at a time?!

<u>Technology that can help.</u> *(when used properly)*

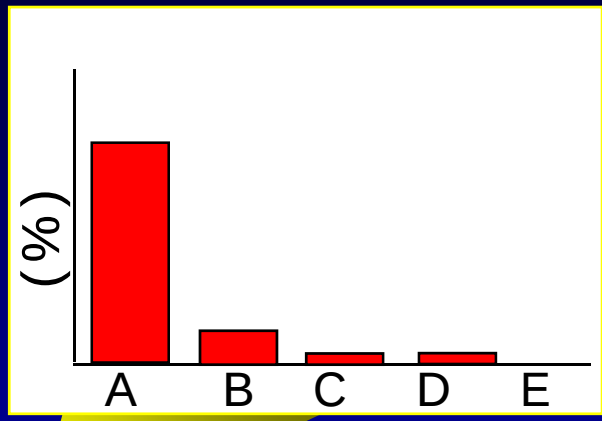
examples:

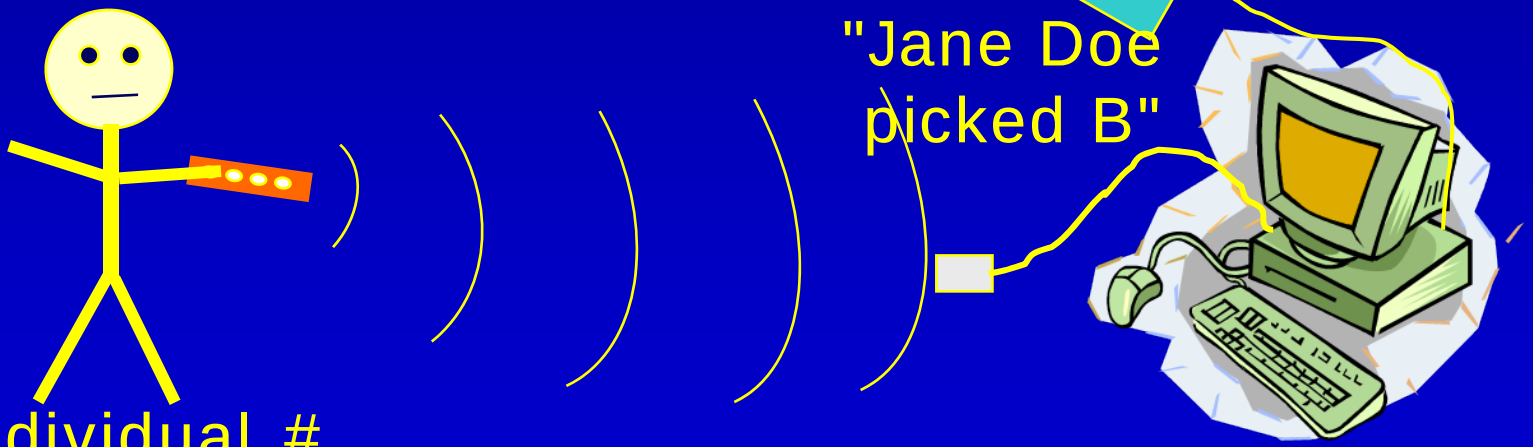
a. Interactive lecture (students discussing & answering questions) *supported by* personal response system--“clickers”

concept questions with “Clickers”--



When switch is closed, bulb 2 will
a. stay same brightness,
b. get brighter
c. get dimmer,
d. go out.





clickers*--

Not automatically helpful--

Used/perceived as expensive attendance and testing device⇒ little benefit, student resentment.

Used/perceived to enhance engagement and feedback (practicing expert thinking and listening)
⇒ transformative. Learn more & like better.

- challenging questions-- concepts, decisions, reasoning. (including before covering topic)
- student-student discussion ("peer instruction") & responses (learning and feedback)
- follow up instructor discussion- timely specific feedback
- minimal but nonzero grade impact

*An instructor's guide to the effective use of personal response systems ("clickers") in teaching-- www.cwsei.ubc.ca

Expert listening / processing interlude--

Does this make sense?
Where and how applies more generally?
What does this mean in my subject?
How relates to other material discussed?

matches idea that learning is brain development, happens only with active practice

remembering something not often used??

5. Retention. Lots of research, results clear.

5. Retention-- Achieve through spaced, repeated retrieval and application of knowledge, & build multiple connections.

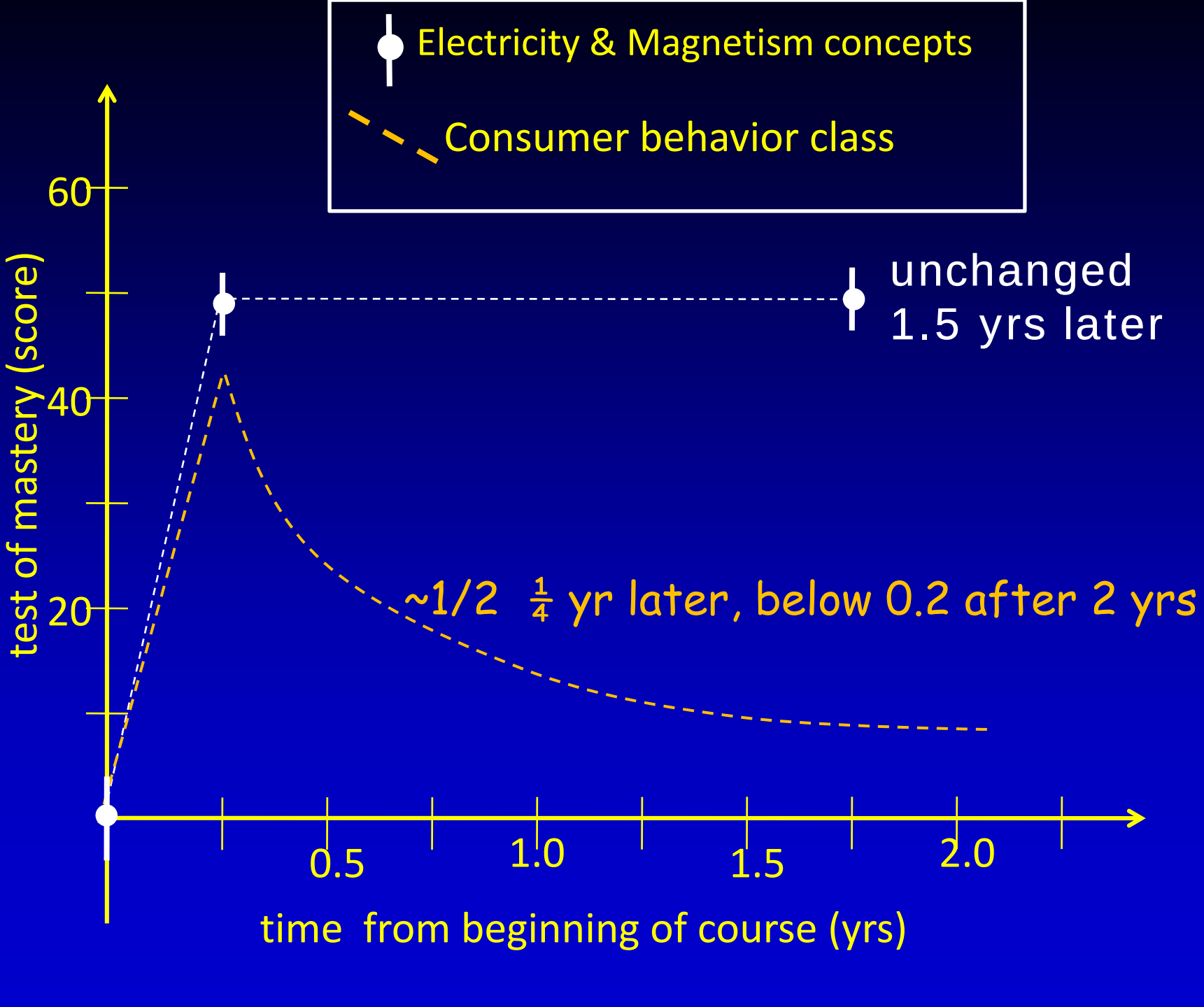
Bad--

- study time mostly cramming for exam
- memorizing as isolated facts
- get it right once, then only focus on new stuff

Good--

- study & test repeatedly, spaced in time
- learn with connections
- regular cumulative testing (formal or self)

take-home lesson


Electricity & Magnetism concepts
Consumer behavior class
unchanged
1.5 yrs later
~1/2 ¼ yr later, below 0.2 after 2 yrs
test of mastery (score)
60
40
20
0.5
1.0
1.5
2.0
time from beginning of course (yrs)

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5. Retention-- spaced repeated retrieval. Connections.

References:

Many references given on CWSEI website:
www.cwsei.ubc.ca/resources

Excellent book: How People Learn (National Academy Press)

These slides will be posted at http://www.cwsei.ubc.ca/calendar.htm

- extra unused slides below

Preparing students for teaching/learning effectively in lecture (Dan Schwartz)

“Preparing to learn”--teaching expert thinking

http://www.cwsei.ubc.ca/resources/files/Teaching_Expert_Thinking.pdf

Students struggle with certain type of problem in topic, **before** hearing about it.

⇒ more expert-like mental processing in lecture. Learn much more

$\Rightarrow$ tiny fraction retained from typical science lecture. Seen in many studies.

I. Redish- students interviewed as came out of lecture.
"What was the lecture about?"

only vaguest generalities

II. Wieman and Perkins - test 15 minutes after told nonobvious fact in lecture.
10% remember