

# Memory biases and curricular illusions

CAMBRIDGE ASSESSMENT

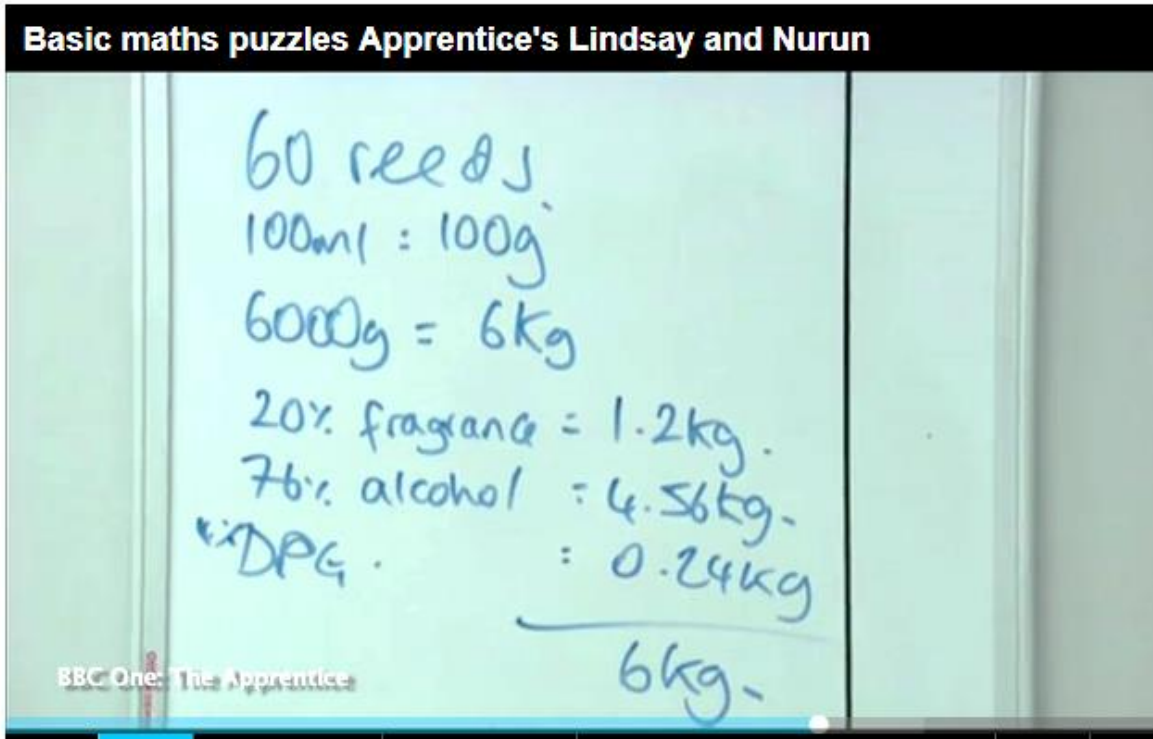
OCTOBER 20, 2016

4:30-6:30 PM

Helen Abadzi  
University of Texas at Arlington

# Long-term consequences of curricular decisions:

Two women fired from the “Apprentice” show for inability to do math calculations (2014)

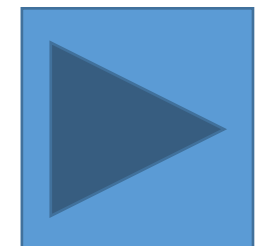


## The problem that left them baffled...

TO make 60 scented reed diffusers, team Summit had to calculate the total amount of fragrance they would need. They were told each of the reeds needed 100ml of scent, and 100ml of scent weighs 100g. By simply multiplying 60 by 100, they would have found they needed 6,000g (6kg) of scent.

But the calculation was too much for Lindsay Booth and Nurun Ahmed who yawned and said they were unable to understand the maths.

“Maybe she went to the wrong school, where they teach 'other things'”



All math curricula include topics needed for the 'Apprentice' problems

- But how much practice do students get in the operations and transformations?
- How many hours of practice do average people need to calculate fluently and automatically?
  - These are rarely researched
- Practice initially requires intense engagement, may be disliked
- Fluent and automatic adults do not see the difficulty
- *'This task is dead simple' 'Choose a nice scent, package it nicely and work out your costs and your margins. There is nothing much to understand in this.'*

Systematic memory biases may affect the skills of the UK population

# UK National curriculum reform

## Millions of different opinions – some influential



How math is taught  
[practice not mentioned]



Pupils will have to know times tables by age 11 under new tests

**Letter from a curious parent** / “  
Dear Ms Morgan, your thinking is from the stone age  
**Michael Rosen**

Why does an anonymous authoritarian prescribe what our children learn? Instructing teachers on what they 'should' do takes away the excitement of discovery

**Still here: reflections on later life** /  
“No more national curriculum?  
What a rosy time for the teaching profession  
**Michele Hanson**

The prime minister wants teachers to take back the power in our schools - sorry, academies - and do away with the pesky national curriculum, interfering Ofsted and local authority rule. What could possibly go wrong?



National curriculum is damaging children's creative writing, say authors

**Teacher's blog** / Reading lessons: why synthetic phonics doesn't work

As World Book Day approaches, academic **Andrew Davis** argues that the synthetic phonics check isn't an appropriate way to teach or assess reading among primary students

# Some common statements about learning

## How many of you believe that..

- Students don't have to know information; they can look it up on the internet
- Schools kill creativity
- Schools should teach critical thinking **rather than** memorization of facts.
- A witness in the courtroom should remember what happened on January 16, 2016 (or any other date)
- Students get bored easily when they are told to practice various skills
- If you don't understand what you read, you are not really reading.
- Everyone learns in their own way
- I am pretty good with multitasking, it does not hurt my performance
- The 21st century has brought **new forms of knowledge and learning.**
  - Schools must adapt.



# Memory principles in 15 minutes

RESEARCH MAINLY FROM COGNITIVE PSYCHOLOGY

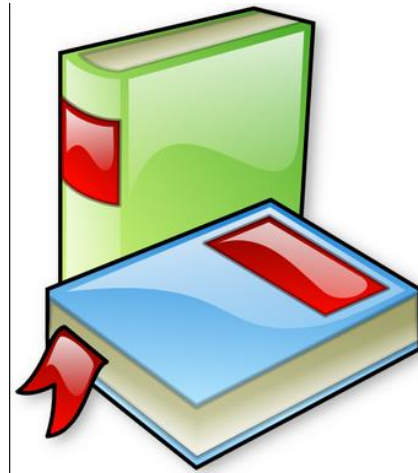
NEUROSCIENCE VALIDATES AND EXPLAINS

We have roughly two kinds of memory  
Explicit and implicit

- Conscious recall of events and rules
  - Episodic – personal memories
  - Semantic – facts and conscious rules

Semantic memory partly comes from

- books, lectures, discussions



# Implicit memory: Knowledge how to do things

- tying shoelaces

It is complementary to episodic memory

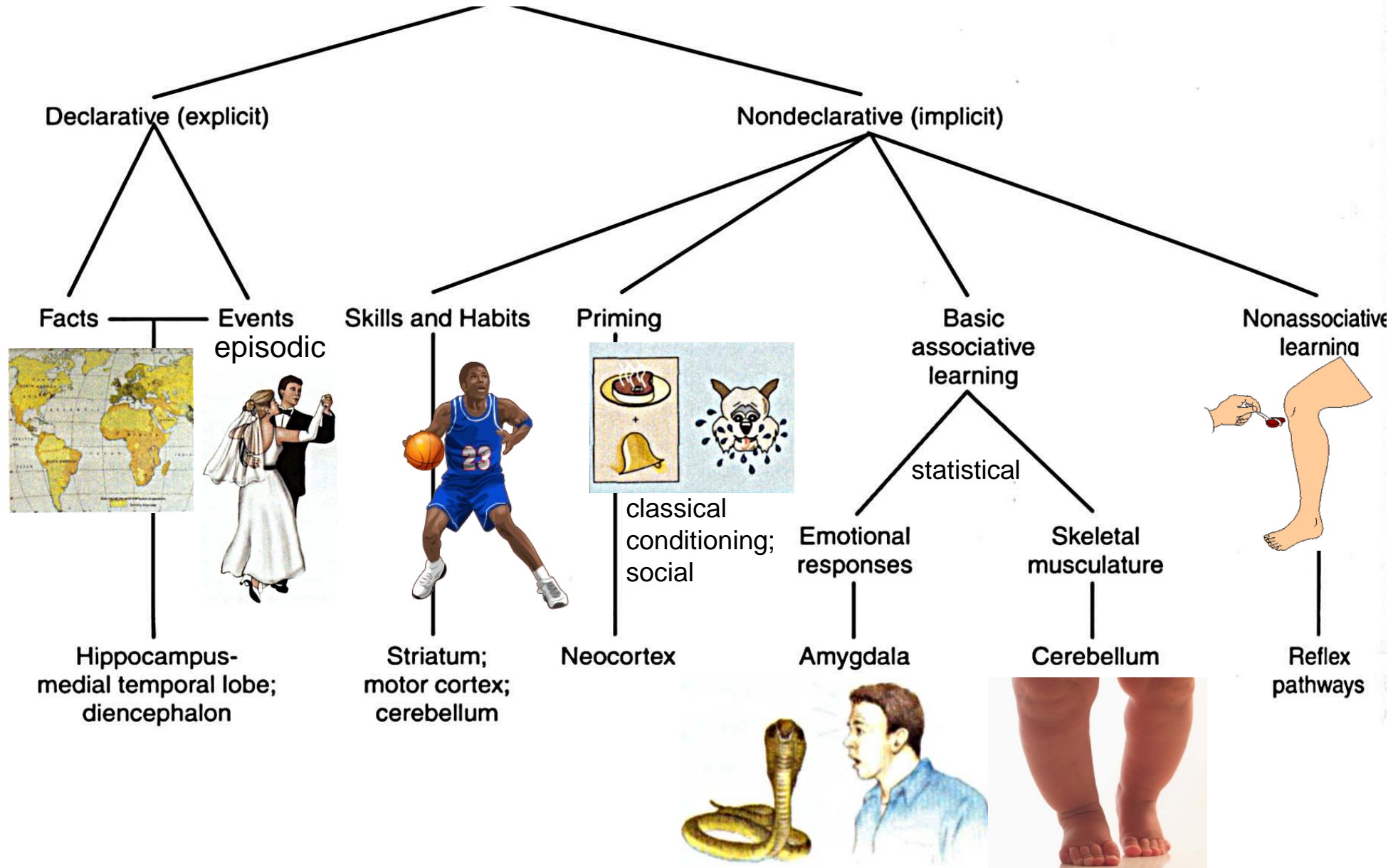
We cannot easily talk about it!

We don't know how we learned it!

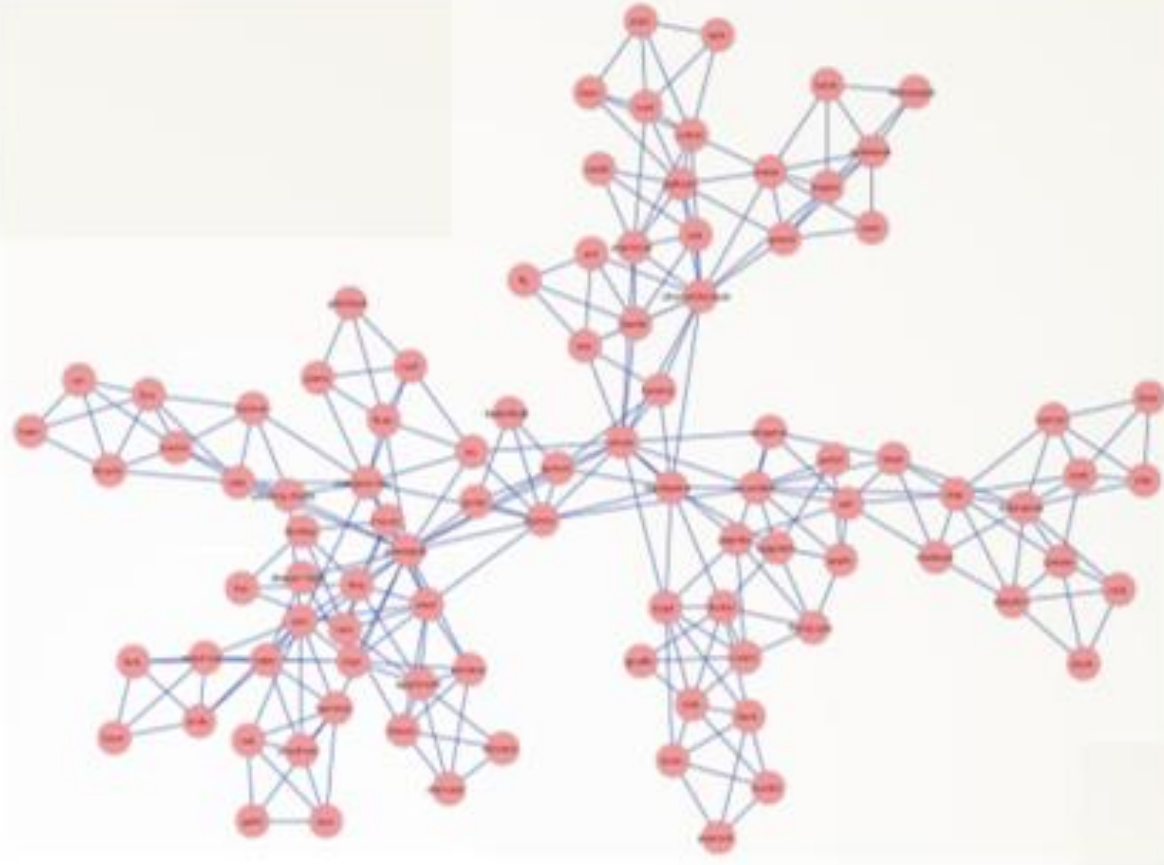




# Long-Term Memory types



Where does the info go?  
Our knowledge is organized into networks  
Classified into categories



Whatever we learn must  
be attached somewhere

For both implicit and  
explicit memory

1970s research validated by  
neuroscience

Memory: changes in our neuronal networks  
strengthening, weakening connections

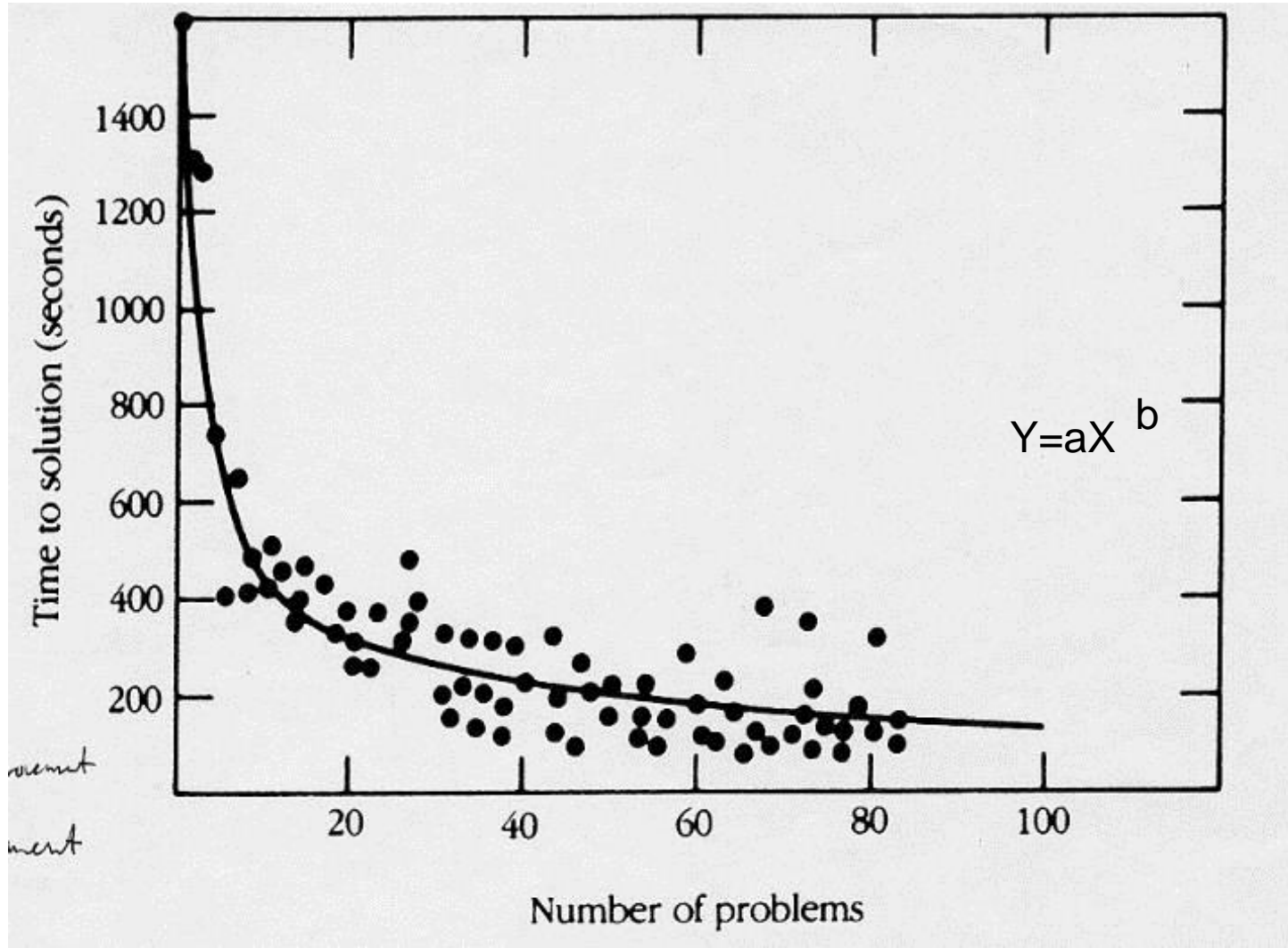
- Few neuronal connections can be made at a time
- Consolidation requires repetitions
- Protein building takes time. So...
- Small bits learned at a time
- Practice is necessary!
- Feedback is needed for modification
- We remember best the info we have used most recently and most often
- **Time on task and feedback matter!**



# Learning and Forgetting curves

Mathematical trends

We may forget most of what we learn



# Teachers are in the construction business

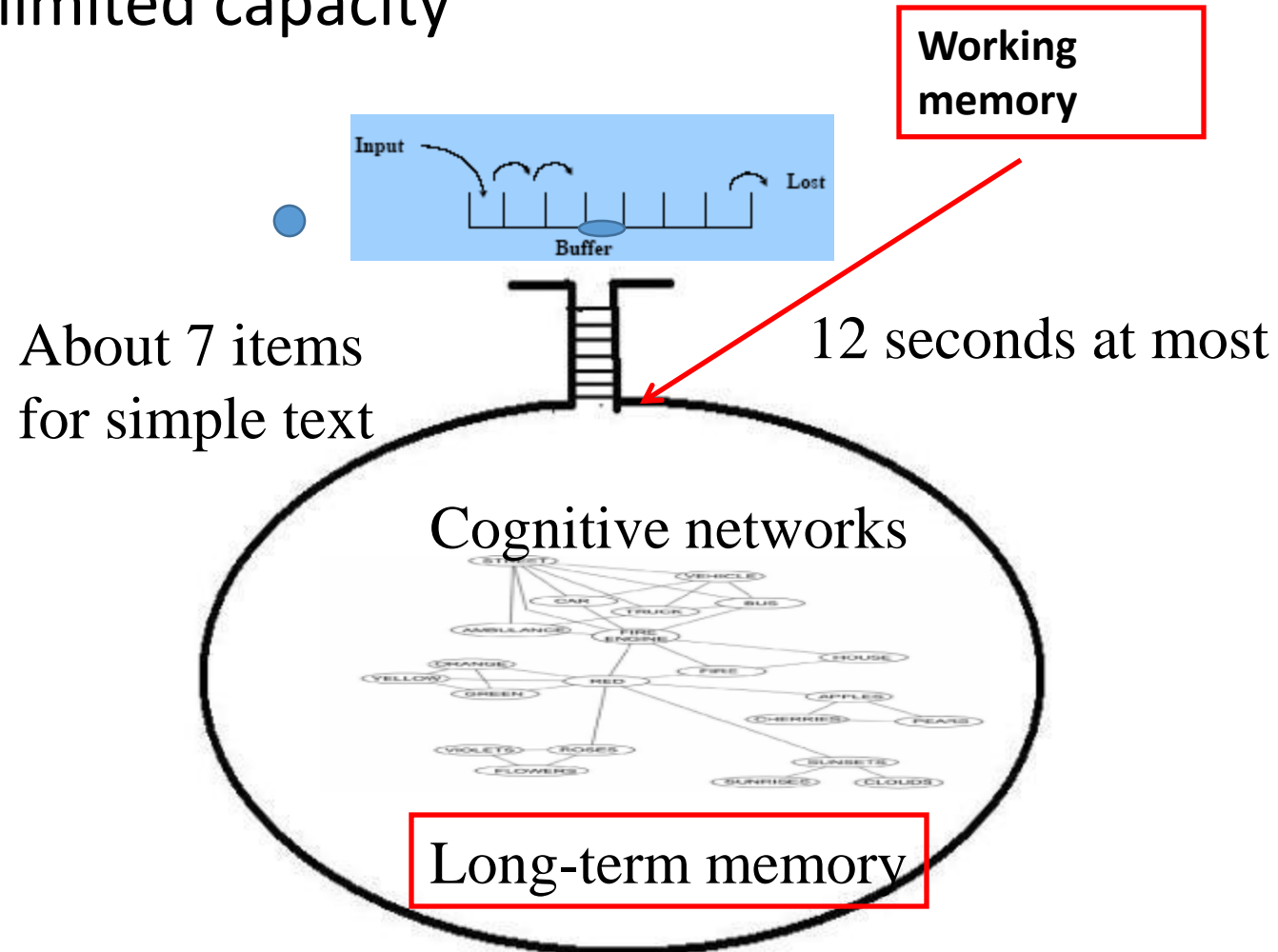
## Memory networks as bricks and mortar:

- Networks: nodes are bricks and links are the cement
- Must lay the first floor before the second
- Bricks
- How laid
- What cement



# Explicit long term memory has a barrier: Working memory

- Very brief period of time
- Very limited capacity



Certain implicit memory tasks  
bypass working memory

# Working memory

gives us only a few pieces of information at a given moment

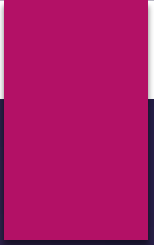
We are prisoners of our memory!

Which info will rush into our minds first?

Those items determine what we understand decide

Education must somehow optimize the access





How good is your short  
term memory?

Your working memory?

HERE IS A SMALL TEST



# You can only escape the working memory prison through practice

- Practice alleviates processing constraints
- turns small items into long chain that is automatically executed
- They pass as one piece through working memory
- Working memory requires speed!

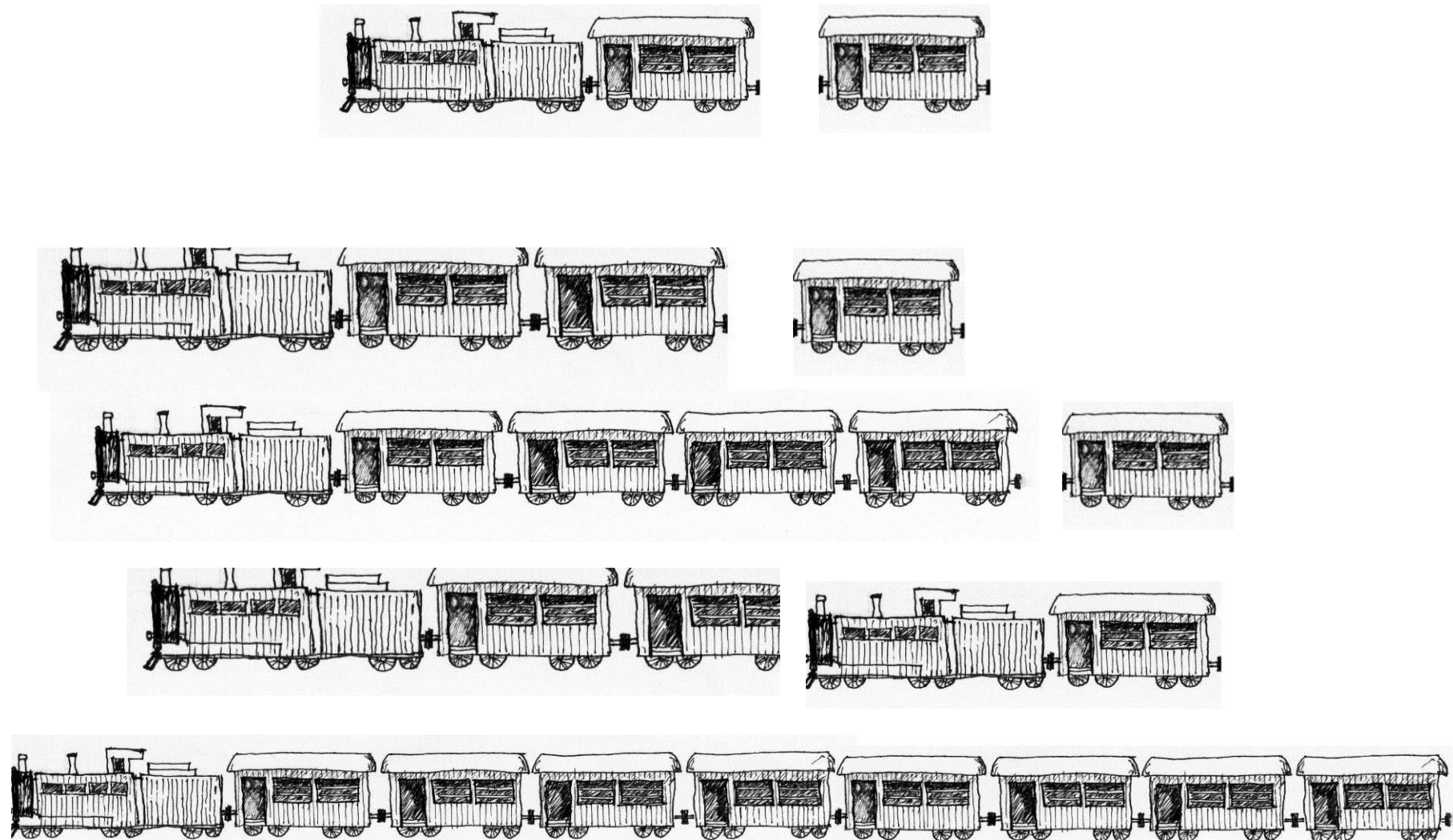


# Chunking

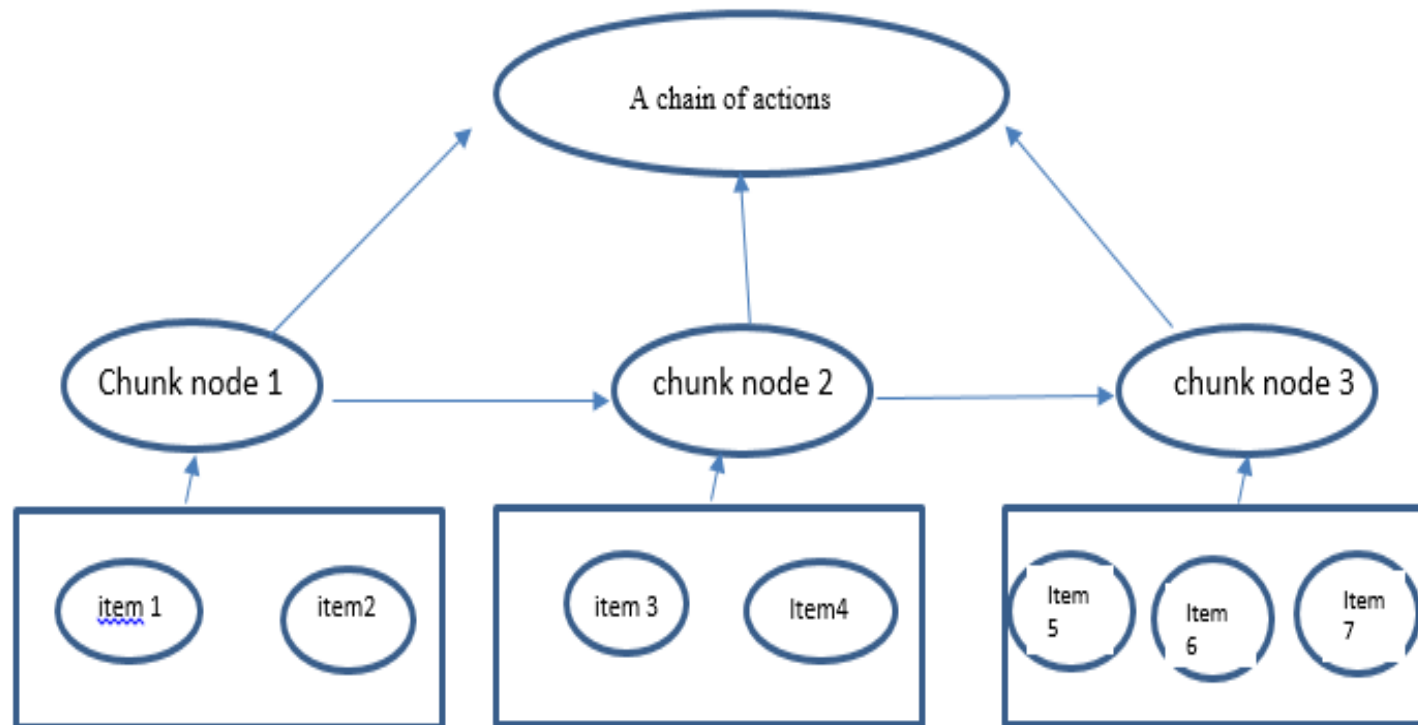
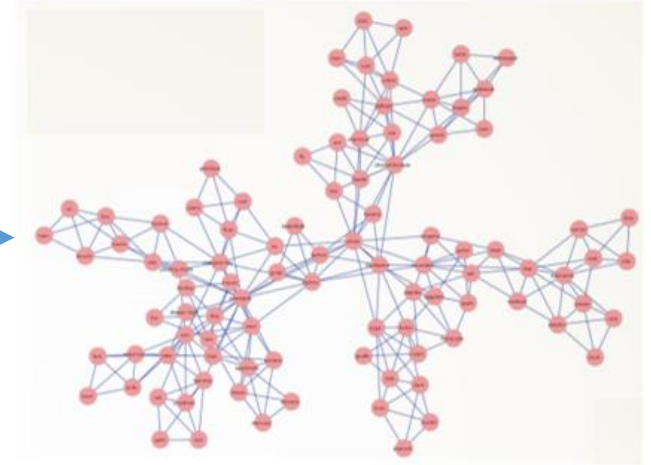
## needed to put much info into working memory

- With some practice the mind joins items of information together
- Chunked pieces pass through working memory as one
- And you can only form big chunks from smaller ones

# An illustration of chunking



Complex competencies and skills arise out of this chunking  
Items are attached to cognitive networks  
Usually on the basis of meaning  
Classification categories are crucial for economy

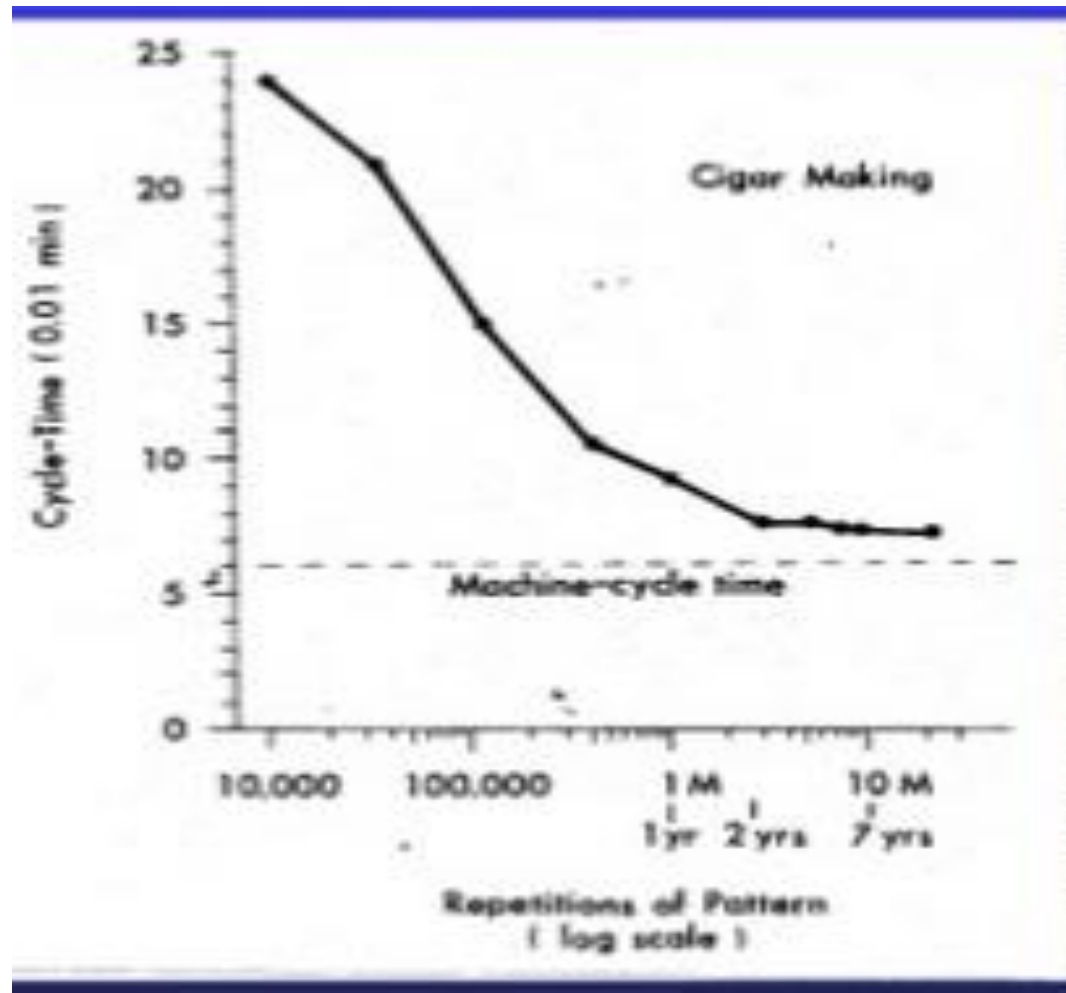


Patterns make easy chunks  
pattern detection therefore facilitates automaticity

	<b>a</b>	<b>e</b>	<b>i</b>	<b>o</b>	<b>u</b>	
						$2 \times 1 = 2$
B	ba	be	bi	bo	bu	$2 \times 2 = 4$
						$2 \times 3 = 6$
C	ca	ce	ci	co	cu	$2 \times 4 = 8$
						$2 \times 5 = 10$
D	da	de	di	do	du	
F	fa	fe	fi	fo	fu	
G	ga	ge	gi	go	gu	
H	ha	he	hi	ho	hu	
Etc						

Practice reduces reaction time  
Neural activity changes with practice

Number of Cuban cigars rolled over 7 years - 1959



# Overlearning protects from forgetting

- Skills get better past observable improvements
- Acquired skills must compete with many others that are coming
- Those who practiced the most forget the least over time
- Two students may have the same scores, and one may forget a week later
- Testing implications
  - Those who crammed may pass a test today but fail a week later
  - Those who overlearned may still pass the test a month later
- It may be useful to give timed and repeated tests on essential skills

# But cognitive load must be optimized Students challenged sufficiently

- As students perform the basics faster, topics must become more complex
- Sometimes students are kept practicing a skill long past automaticity
  - Overlearning consolidates for the long term, but gotta move on
- E.g. in the US a technique called "**leveled instruction.**"
- **Students spend the vast majority of their time in a text that is at their reading level.** So if a fifth grader reads at a third-grade level, they spend most of their day reading texts at a third-grade level."
- How can teachers practically determine how to optimize cognitive load? unclear



# Implications of working memory: Fluency must be the goal of all training

- We must do effortlessly, no time for searches:
  - Reading
  - Math calculations
  - Driving a truck
  - computer operation, etc.
- Chunks must start small, be learned gradually
  - If the small chunks are unknown, remediation is necessary
- Chunks must be available in milliseconds
- Speed and automaticity are prerequisites for complex thinking
- Average numbers of hours needed to perform fluently in essential tasks ought to be researched



# Better off families have brains in better condition Longer working memory

**Even incremental income rises of a few thousand dollars were associated with major changes in the brain's structure, especially in areas responsible for decision-making.**

**the poor have 6% lower brain volume**



*Photo Illustration by Dair Massey/The Daily Beast*

Clearly, well-to-do children have an advantage

It is expressed by parents and sanctified in national curricula

Schools teach a great deal of content  
We must automatize basic items early on

- Grade 1 is most important, everything should load on it!
- Revive memorization to facilitate fluency
- Multiplication tables, poems with vocabulary to retrieve decades later
  
- To reduce effort, optimize encoding into implicit memory where possible
- But more research needed on implicit memory use for instruction



# Systematic memory biases

WE FORGET WHAT WE FORGOT!

WORKING, IMPLICIT MEMORY ARE UNCONSCIOUS

Lack of implicit memory awareness = source of bias

- We are aware of memory products, not processes
  - Our meta-memory is seriously biased
- Highly educated people have forgotten the 20,000+ hours they spent practicing
  - “it’s so simple!”
- We systematically overlook low-level processes and focus on complex concepts:
- Creativity, innovation, critical thinking, reflection, collaboration, communication

# Memory illusions are widespread

- respondents agreeing with propositions that conflict with expert consensus:
- memory works like a video camera (63%)
- memory is permanent (48%)
- the testimony of a single confident eyewitness should be enough to convict a criminal defendant (37%)

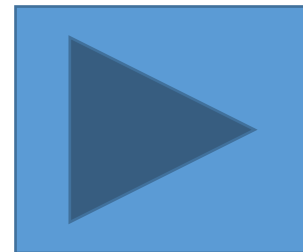
# Cognitive biases have been studied extensively

- **Based the inequality between implicit and explicit memory**
- **System 1 - efficiency – implicit memory**  
**System 2 – when it really matters or there is time**  
**Daniel Kahneman**

# Availability heuristic very common in education

- People tend to assess the relative importance of issues by the ease with which they are retrieved from memory
- Middle-class children's knowledge and pace shape national curricula
  - Poorer students by definition fall behind, must catch up to middle class norm
- Curricula of earlier decades less demanding, middle class probably knew less

- Mozambican officials in 2007: No illiterate students in Maputo





We perceive patterns that do not exist  
Covariation illusions

We connect unrelated occurrences

Magical thinking, superstitions

Generalizing from a single case to the entire population

Infer result from action, because this linkage is familiar to us

- And: What you see is all there is

Some good news: a single training session can overcome some biases

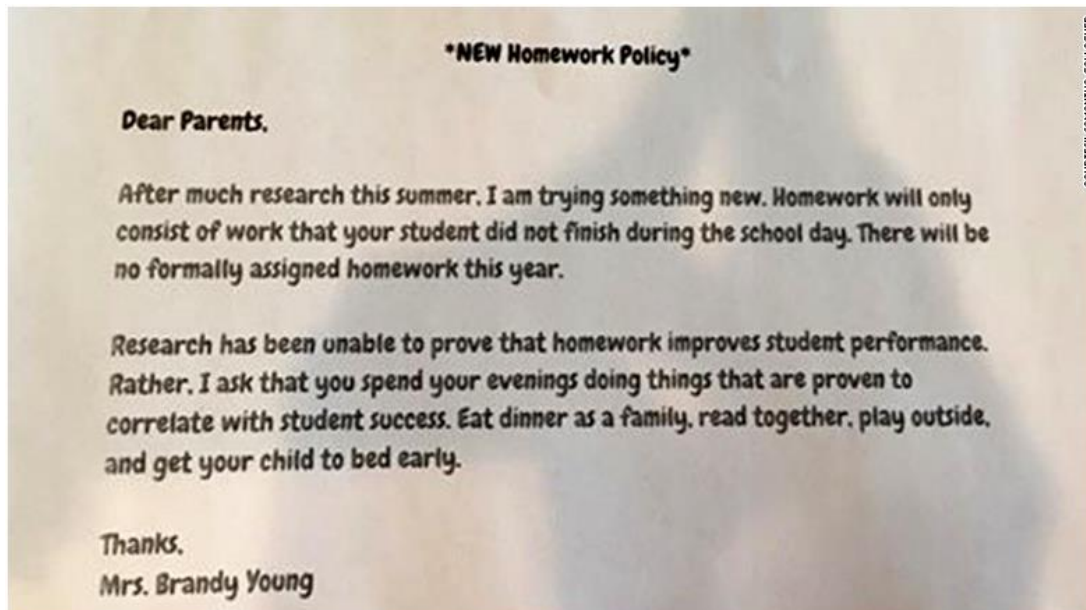
# Opinions and messages from press, blogs, politicians, educators, parents reflect biases

- Memorizing facts, drill is bad; students must be active
- Traditional teaching is bad; innovative teaching is good
  - No evidence presented
- Dump textbooks and curricula, let students decide what to learn
- The 21<sup>st</sup> century skills demand new educational paradigms
- Technology, gamification, flipped classrooms the future of pedagogy
- Primacy of fun in education
  
- **Beliefs shape budgets, programs, politics**

# Automaticity and homework in the UK

Homework is becoming outdated

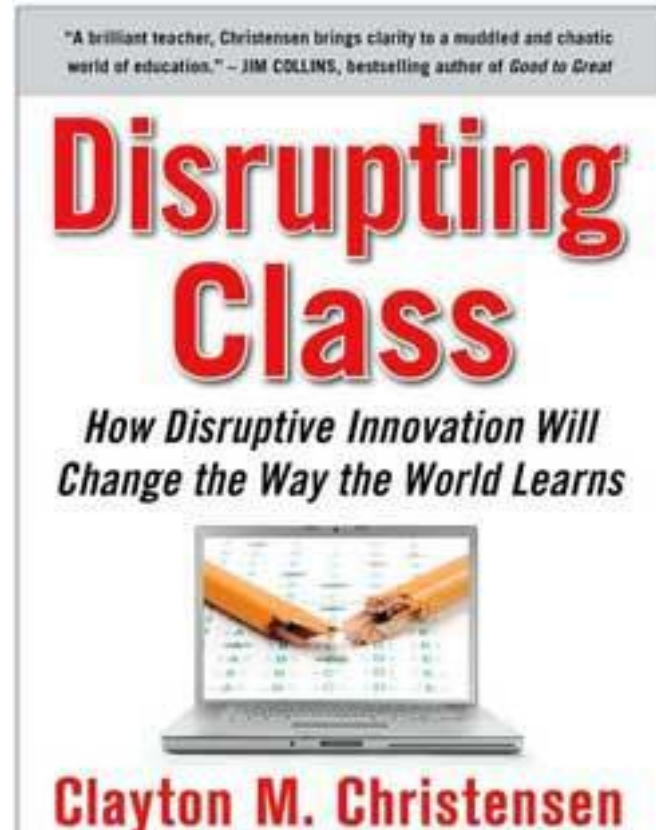
No research on average hours needed to automatize tasks



It's no homework, all year long for one group of Texas second graders.



The brain will learn anything and has no limits  
The DNA of average people was not consulted



MIT scholars envisaged rapid learning for poor students  
Easy literacy, numeracy, geometry, coding!

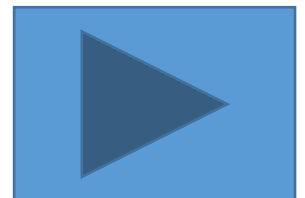


The contest of the availability illusions:  
World Bank created programs based on staff memories  
about their own quality schools  
The poor have seen less, satisfied with poor quality

Nepal:



Communities are supposed to take action  
But the poor may be satisfied with poor quality  
Heuristic available for them



Nepal

Donor staff thought communities could finish the school buildings

Were they right?



Our views are heavily biased by others' opinions

- Invisible authority
- It is recommended that....
- Dr. X is highly regarded...
- Best practices !
- Everyone else is doing it



# Invisible authority also considers results a done deal

<b>Traditional Classroom</b> (Proving - Performance Orientation)	<b>Personalized Learning Environment</b> (Improving - Learning Orientation)
Teacher-centered	Learner-centered
Learners follow instructions	Learners actively participate in learning
Goal is correct answer	Goal is for deeper understanding
Whole class lesson with learners working alone	Learning happens individually, in pairs, threes and in groups
Teacher gives times to answer questions	Message is on improvement with a focus on effort
Learners focus on tests and grades	Performance linked to effort and progress

Students sitting and listening is viewed as a negative thing  
Yet highly effective for brief periods



Critics' concern: How relevant is the content to current students' needs?  
Future needs not considered

# Expunge memorization!

- “The way we learn today is just wrong”.
- Learning needs to be less like memorization, and more like... Angry Birds.
- How do we get our kids to want to learn?
- Flip our current model on its head, key exponential technologies like AI, VR and gamification will drive a revolution in education.
- But British polymaths who memorized Greek and Latin made significant 18-19<sup>th</sup> century discoveries

# Learn math without fear, says expert no need for multiplication tables

Students most effectively learn "math facts" working on problems that they enjoy, rather than through exercises and drills they fear.

Speed pressure, timed testing and blind memorization damage children's experience of math

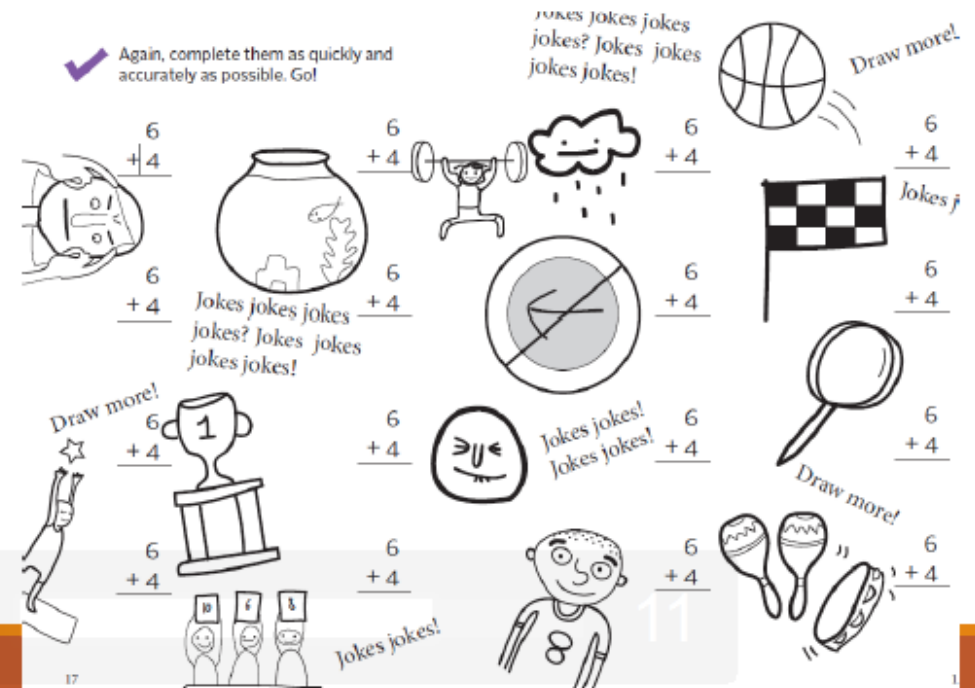
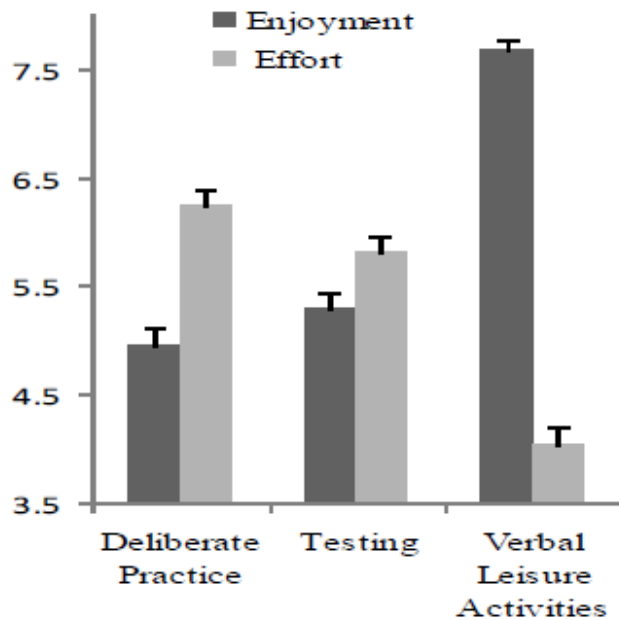


Teaching through fun is great, if no time constraints  
But governments finance instructional time!

# Rejection of deliberate practice as not fun!

## Teaching Grit: Two approaches 1) Consequentialist

Deliberate practice is hard...and not that fun



# Stop Teaching, So Students Can Start Learning



Parents, policymaker want something more for the students. What?

# The bias elevates procedural memory Activities are somehow seen as 'real' learning

But implicit and explicit memory must come together for effective use in life



Open Connections students inject shitake mushroom spores into logs.



Students hook up a Lego cable car.

# UK Parents may intervene on content they consider irrelevant

- Guardian article: Boycotting school because of the pressure on our young children
- On students learning material that the parents consider irrelevant:
- Journalist criticized the term subordinating conjunction for his son
- Why learn content that does not interest students?

British polymaths of the 19<sup>th</sup> century



# Campaigns in favor of freeing children to be creative

What are the unspoken assumptions?

- British author and advisor Ken Robinson

- “schools kill creativity”

- 

"Recognise that fresh ideas have their origins in keeping your imagination fertile. So do new things. Keep your mind alive. Feed your store of ideas. Open your mind to new possibilities and experiences."

- If you are not prepared to take a risk, then don't expect innovation."
- And what better way to open your mind than go outside and play.



# The well-to-do complain against structured and layered content (remember cognitive networks)

US or the UK should do away with curricula, syllabi

- Or teachers should develop their own curricula
- “Standardized tests failed: New education philosophy needed”
  - 2010
- Argument: computers now crunch data, humans don't have to
- “Older school curricula tended to focus on reading writing and arithmetic with an emphasis on teaching students specific information. Because students learn and remember facts best by actually putting them to use, older rote memorization techniques are no longer regarded by many educators as the best approach to education.”

# Ditch that textbook!

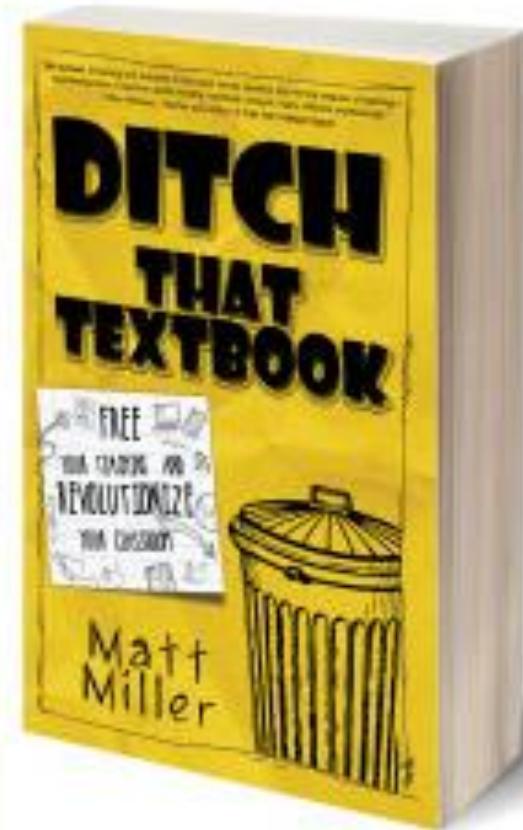
Ditch the students' classification scheme??

Hidden teachers' issue:

How to manage classes

How to keep students' attention?

How not to lose face when students don't do homework?



in England only 10% of students' teachers use maths textbooks as the basis for their teaching compared to 70% in Singapore and 95% in Finland

# What's right about textbooks?

- Categorization schemes
- Classification under categories
- Definitions – precise retrieval
- Figures, pictures
- Elaboration of concepts
- Available to be read again
  - The more elaborate the better
- Questions and checks
- Therefore reconsolidation of memory from class or notes
- Retrieval path!

## **Why textbooks count**

A Policy Paper

**Tim Oates**

**November 2014**

Mindset, self-confidence make the difference  
Just name and claim knowledge!  
If you just wish it, it will happen

The treatment  
was counseling  
sessions

### Targeted skills

**MCII → WOOP**

**WISH**

**OUTCOME**

**OBSTACLE**

**PLAN**

**6**

**11**

**WORLD BANK GROUP**

**"If I have the belief that I can do it,  
I shall surely acquire the capacity to do it  
even if I may not have it at the beginning."  
- Mahatma Gandhi -**

**TWO MINDSETS**  
CAROL S. DWECK, Ph.D.  
Copyright © 2006

**Fixed Mindset**  
Intelligence is static  
Leads to a desire to look smart and therefore a tendency to...

**Growth Mindset**  
Intelligence can be developed  
Leads to a desire to learn, improve and therefore to...

**CHALLENGES** → **CHALLENGES**

**OBSTACLES** → **OBSTACLES**

**EFFORT** → **EFFORT**

**CRITICISM** → **CRITICISM**

**SUCCESS OF OTHERS** → **SUCCESS OF OTHERS**

As a result, they may choose only and sometimes their own "I'd prefer not to" path.

As a result, they maintain higher levels of achievement.

All the great ones have a growth sense of their self.

**WISH**

**OUTCOME**

**OBSTACLE**

**PLAN**

**WORLD BANK GROUP**

# Belief that self-confidence will overcome a lack of automaticity

Affirmation Theory: Propose that students' motivation is rooted in their beliefs about why they succeed or fail. Students can be taught to understand that failure is the result of a lack of effort instead of a lack of ability.

## Example Messages



"People have myths about math, like, that only some people are good in math. The truth is that we can all be successful in math if we give it a try"

"We will learn new skills only if we are persistent. If we are very stuck, let's call the teacher, or ask for a hint!"

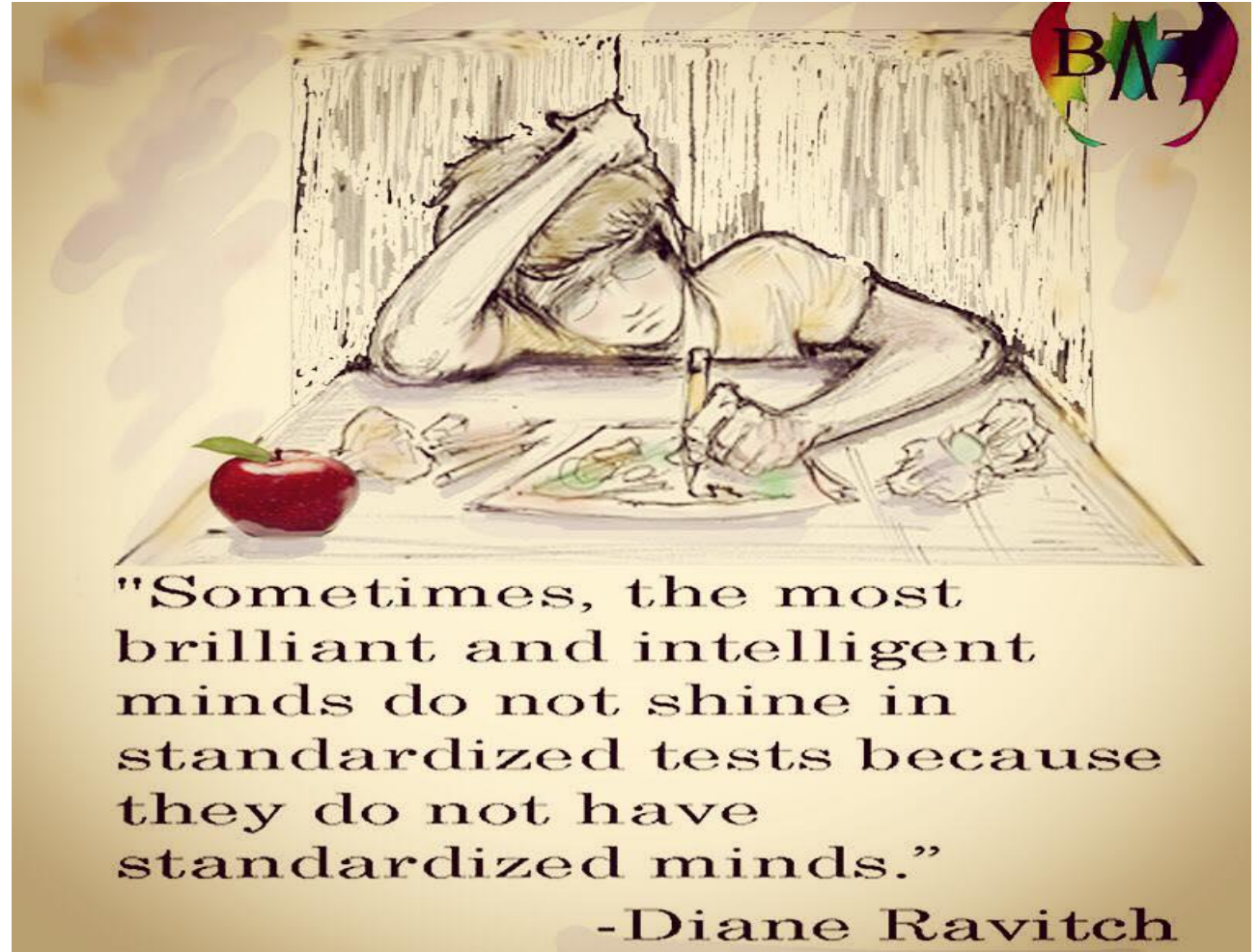
"When we realize we don't know why the answer was wrong, it helps us understand better what we need to practice."

# Testing is subject to a zillion biases

Anti-testing crusades

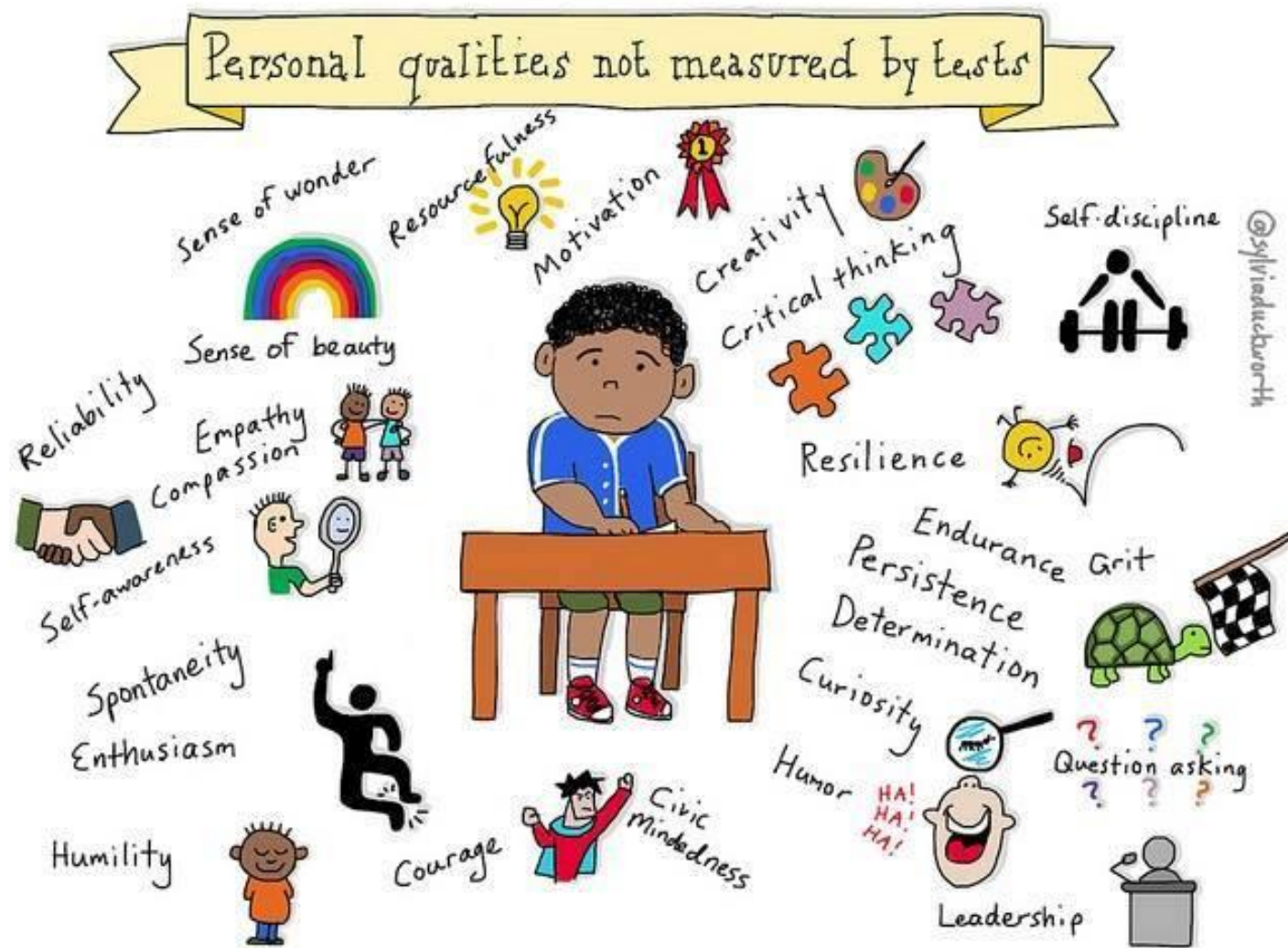
But  
Cognitively demanding  
tasks are unpleasant

Can be high-stakes, socially  
questionable



Particular leniency towards boys

# Emotionally appealing crusades against testing





Even some neuroscientists get carried away:  
Teach to the heart, not to the test!!

## Scholarly Blog

# Teaching Beyond the Transmission of Knowledge



📅 August 1, 2018

📌 Education,  
Educational  
Philosophy, Higher  
Education,  
Intercultural,  
Learning,  
Psychology, Social  
Philosophy

*«Teaching to the test at the expense of teaching to the heart is wrong and reduces education to a very superficial acquisition of knowledge and values. Standardized testing for measuring knowledge, skills and attitudes goes against learning styles and individual differences.»*

# Politicians' confusion about learning processes

- Blogger's argument: it is pointless to learn foundation skills
  - In 20 years, today's jobs will be gone



## Education review 2013: Michael Gove continued to promote 'traditional' schools

**Schools:** Michael Gove forged on with his plan to return to the good old days, and called his critics the 'enemies of promise'

17 Dec 2013 71

# Conservative governments more interested in basic skills

- But unable to explain rationale
  - Implication from a learning perspective
  - Students at age 11 asked to study and review, increase basic skills fluency
- 
- Confusion with social issues sparks controversy

## Michael Gove's national curriculum reforms: where's the creativity?

We could look to the unconventional Lumiar schools in Brazil, which believe that children learn best when they have a say in what they're learning

But to create something, we must know a great deal about it and get the info in our working memory lightning-fast.



Ricardo Semler: 'We are trying to prove that by giving kids freedom, they will in the end be better educated.'



# New challenges to learning

MISCONCEPTIONS ARE ONLY A PART OF THE PROBLEM

# 21<sup>st</sup> century threats to basic skills competencies

- Children multitask, do not consolidate “deeply”
  - They remember an internet search pathway but not the answer
  - Will grow up with less info in their heads
- They start adolescence 1-2 years earlier
- Teachers may find it more convenient to just please students and do less drill
- Textbooks are super expensive.
- Science remains unknown; cognitive scientists deal with other topics, remain obscure
- Policymakers responsive to citizens’ educational demands

# Internet, computerized information have worrisome effects on memory

- Cognitive 'offloading'

People remember how to search but not necessarily the answer

- Internet searches are convincing us we're smarter than we really are
- For some reason, "real learning" appears to be searches, being busy
- Cognitive offloading
- People depend on smartphones to retain their information, memories

Online learning may be more easily forgotten

Students seem to  
devote less time  
Less consolidation  
Illusions of  
remembering

Content-Centered Courses: How Google Has  
Destroyed Traditional Education (And How That's A  
Good Thing)





New tools promise different ways of learning...  
but are neuronal assemblies performing different functions?

Research suggests that  
use of such materials  
may not leave much  
memory behind

### Check Out How These Teachers and Students are Using Augmented Reality



From [www.emergingedtech.com](http://www.emergingedtech.com) - July 26, 11:59 AM

"Creative Commons licenses image source Augmented Reality is one of the most interesting and exciting tools emerging in the academic world today. Here are a handful of videos showing many fun, engaging ways in which educators and students are using"

# “Transformational paradigms” fail to transform memory

- Flipped classes, online training may not leave much in memory. Too little repetition and attention.

# Concerns about students' boredom may minimize practice

- Students presumably do not tolerate boredom
  - Parents may protect them from that
- Should students learn tolerance to boredom?  
Perseverance?
- Is boredom a failure in executive functions?
- Are innovative practices a way to manage boredom?

# Boredom is not a positive trait

- Result of too much and constant stimulation
- Does the advantaged life somehow distort the motivational system?
- And is boredom perhaps a function of constant positive feedback?
- Poor rural populations have fewer options, may have less boredom with the same tasks.

Are child workers bored?  
What options do they have?



# Earlier-onset adolescence

The time to teach students basic skills with little fuss is running out

- Students are maturing earlier and therefore entering adolescence by age 9.
- Then they become unruly teenagers
- Certain sensitive periods may operate earlier
- potentially reading automaticity, maximum reading speed
- Maximum speed in math calculations

# Implications:

We think about education from our biased perspectives

- Some students, including our relatives, really are very smart
- Thus creativity and critical thinking may stand out over constituent knowledge
  - Constituent knowledge is considered narrow
- Lack of training in basic components means inability to learn higher-order skills
- Misconceptions affect curricular decisions.
- Policymakers, parents, students fall for them. The victims:
  - Curricula
  - homework
  - Assessment challenges

# Cognitive science solves education dilemmas but remains unknown

- Essential concepts can be taught in about 20 minutes:
- The overriding constraint of working memory
- The ineffable nature of implicit memory
- The construction business that constructs cognitive networks
- Cognitive biases that arise because our memories are very partial
- The university has academics who know the research, even if they do not think about it in these terms



# The arbiter of education is our working memory! The fastest, best connected information wins!

- We are in bondage, enslaved in an invisible prison
  - We can escape momentarily only if we run faster than the closing door
- We want education to be more interesting, innovative, but we are stuck with drill and fluency needs!
- Ultimately education must put in our memory networks information that can rush into our working memory while we make decisions



# Lack of knowledge in the science results in planned failure of educational reforms

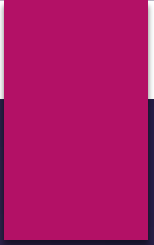
- there is problem
- the research is unknown or not used
- Solutions partly address the problem
- applications reconfigure the system, creating new problems
- back to the top and around again (Achtenhagen)
  
- **We can stop the cycle of planned failure**
- We know enough cognitive science to put it into practice
- Thus avoid cognitive biases

# Countries attempting reform are steered by people who fail to use basic memory facts

- World Bank
  - Economists who went to elite schools
    - Remaking the world in the image of their illusions
- DFID – very well meaning and serious
  - Still not knowledgeable
  - Advisors have partial and misleading models of effective education
- UK, US education systems
  - The haves have basic skills, and the have nots have fun!

# What could Cambridge Assessment do?

- We often sense that arguments are incorrect but don't know how to counter
- Use the science; familiarity with memory operations and implications
  - Base arguments on specific publications
- Weigh in: In blogs, discussions ask what the rationale is
- Emphasize value of lower-level skills before complex cognition
- Stimulate research on poorly understood skills aspects
- Develop tests that measure fluency in certain core tasks, possibly against certain benchmarks



# The UK system should not produce failed “apprentices”

“Maybe she went to the wrong school, where they teach 'other things'”

The UK should use learning science to stay on the forefront of knowledge, as  
in earlier centuries



Thank you for your  
time!