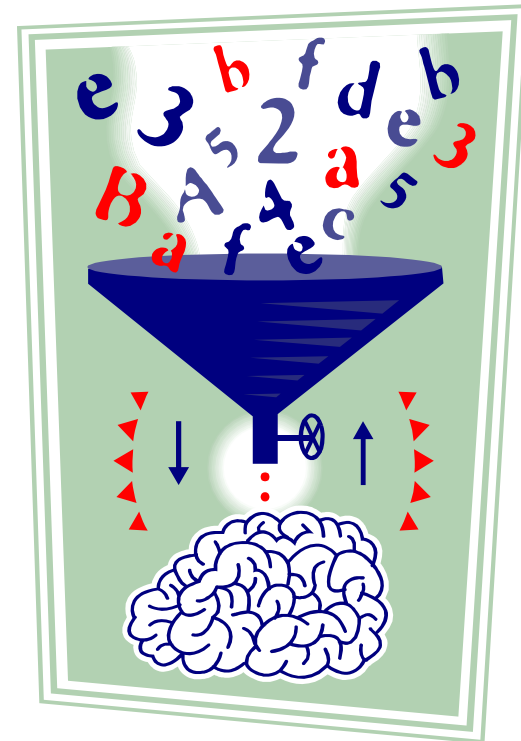


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Mathematics  
New Orleans 2014

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**WHAT DOES THE BRAIN DO WITH  
ALL THAT MATH?**

# Why don't they remember?



## Who is to blame?

*The college professor said, "Such rawness in a student is a shame. Lack of preparation in high school is to blame."*

*Said the high school teacher, "Good heavens, that boy's a fool. The fault, of course, is with the middle school."*

*The middle school teacher said, "From stupidity may I be spared. They sent him so unprepared."*

*The primary teacher huffed, "Kindergarten blockheads all. They call that preparation? Why it's worse than none at all."*

*The kindergarten teacher said, "Such lack of training never did I see. What kind of woman must that mother be?"*

*The mother said, "Poor helpless child. He's not to blame. His father's people were all the same."*

*Said the father at the end of the line, "I doubt the rascal's even mine."*

-anonymous, 101 "Answers" for new Teachers and their Mentors, page 81

# Lexicons

- Lexicons are knowledge stores
- Lexicons can vary in size
- Lexicons can vary in amount of info stored but if it is stored, it can be retrieved
- Lexicons can vary in terms of accessibility as students figure out what to do with information in working memory
- Lexicons can vary in terms of emotional tone and intensity which can impact accessibility



# The NOW

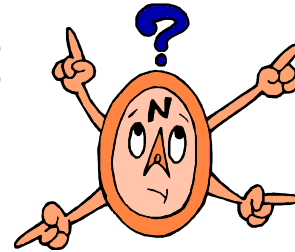
- Initial registration of information requires access of *previously* stored information
- Students must travel to their **lexicons**

It can be scary in there....



# Now and Then

- Initial registration in the “now” requires access to knowledge stores (lexicons)
- If students do not have an organizational structure, **they can't find it when they need it**
- Inaccessibility of previous knowledge is a barrier to learning



# Executive Functions

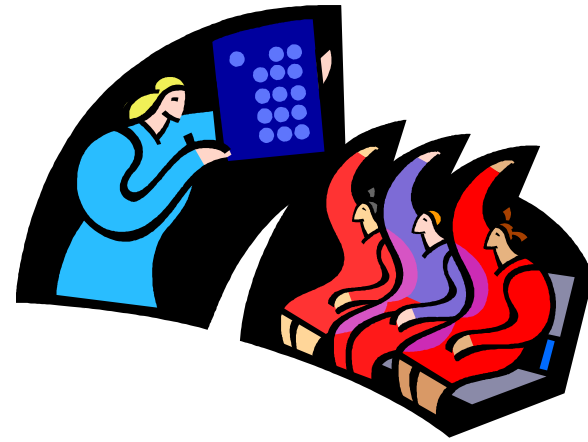
## Who is driving the bus?



- Frontal lobe activity is still maturing in high school students
- The frontal lobes control the cues that provides access to lexicons
- Limbic Area (emotional system) develops faster and matures earlier than frontal lobes
- Emotion drives attention
- Attention drives learning



# What Can Teachers Do?



- Help students to emotionally prepare for learning by creating relaxed, positive emotional states.
- Teach students about information processing by modeling new strategies
- Help students be in the “now” and cue them about what lexicons are likely to be needed for processing
- Cue students about upcoming need to extend information beyond the “now”

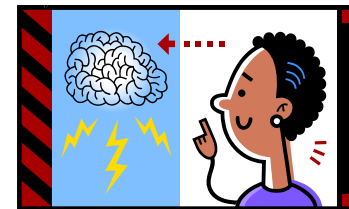


# The Digital Generation

- ❏ The wiring is new
- ❏ Information is processed in a parallel or simultaneous manner
- ❏ Multitasking is a way of life



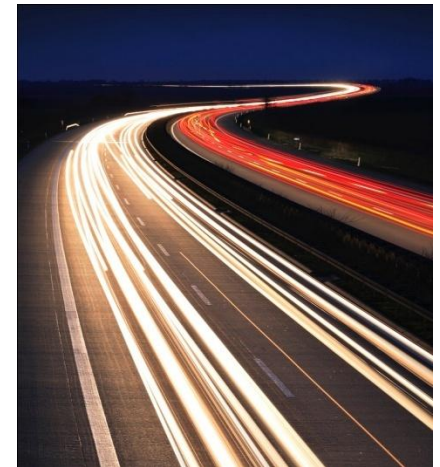
- ⊕ Learning in a sequential, linear manner is a challenge for the digital generation



# Cultural Brains

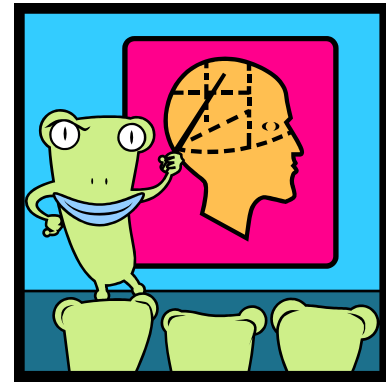
## *the digital generation*

- **Digital bombardment has affected adolescent brains**
- **Brains have become “neuroplastic”**
- **Reading patterns are different**
- **Prefers to access info quickly from multi-media sources**





# Digital Natives



Learn “just in time” vs. “just in case”

New skills are acquired as needed, on demand

Students are growing up in a faster world and  
are fast interactive learners;

Producers vs. passive recipients

# Memory is

# EVERYWHERE

- Memory is not stored in a single location in the brain
- As experience enters the brain it is deconstructed and distributed all over the cortex
  - Emotional and Visual content
  - Procedural memory
  - Semantic memory
  - Episodic memory



# 3 Types of Memory

- Short Term Memory
  - Retention for a few seconds, minutes or more depending
- Working Memory
  - “Desktop” for retrieval of memory for immediate use. When working memory is no longer needed it is partially or totally forgotten.
- Long Term Memory
  - The brain produces new proteins when items from working memory are moved to long term memory

What appear to be memory problems are really difficulties with processing information



# What We Remember...

- We remember **BEST** that which comes FIRST
- We remember **SECOND BEST** that which comes LAST
- We remember **LEAST** that which comes JUST PAST THE MIDDLE



# Layering the Curriculum

Foster higher level thinking skills by connecting new learning to prior knowledge

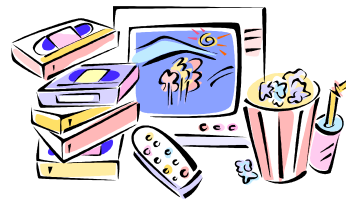
## 1. Primetime 1

- First twenty minutes
- Avoid management tasks
- Do you really want to start with homework?

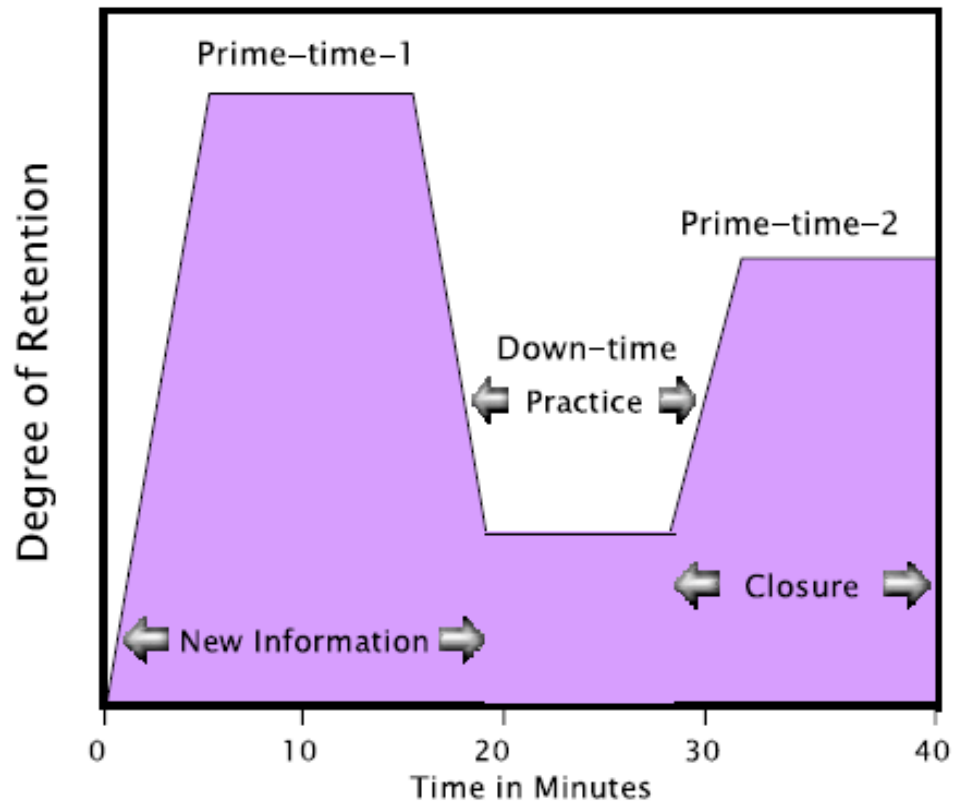


## 2. Primetime 2

- Closure
- Last chance to attach meaning and make sense of new learning



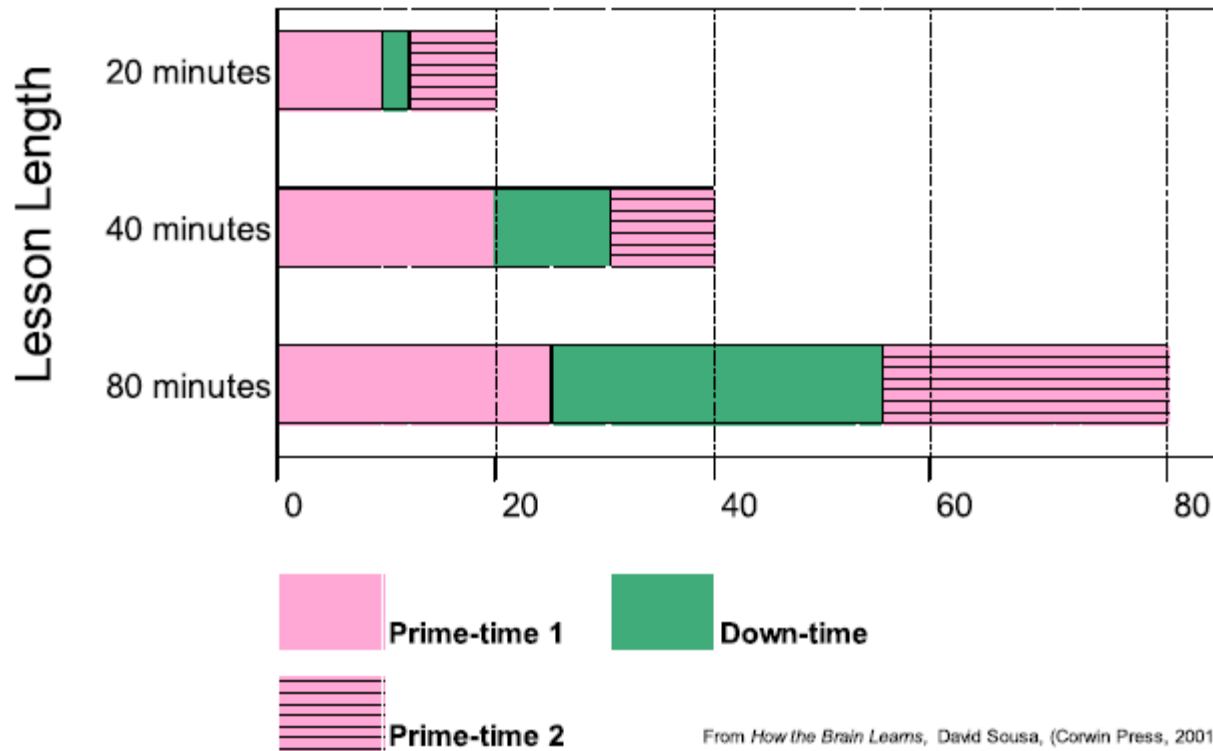
## Retention During a Learning Episode



From *How the Brain Learns*, David Sousa, (Corwin Press, 2001)



## Approximate Ratio of Prime-Times to Down-Time During Learning Episode





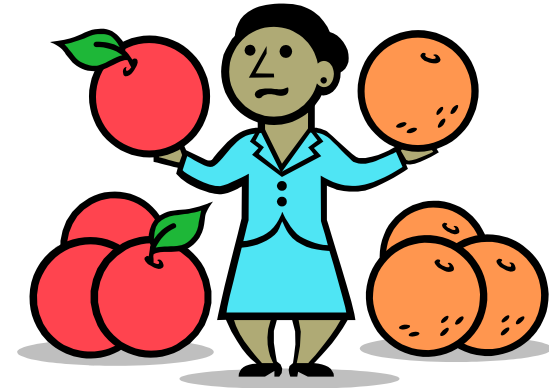
- Between Primetime 1 and Primetime 2 **should be a time where students are given the opportunity to move information and solidify memory.**
- If no meaning is attached then 99% of the learning is lost in 24 hours
- Retention requires the learners to “**hook learning**” to something in their brains

# Making Memories

- **Repeat and Rehearse can be tricky for the digital generation who are immersed in multimedia and acclimated to multitasking**
- **With repeated exposure, novel experiences become routine**
- **The key is to find meaningful and different applications of math to maintain interest**
- **Determine how much practice is needed and then do no more**

# Similarities and Differences

- Brains store using similarities
- Brains retrieve using differences
- If concepts have more **similarities** than **differences**, the **similarities** will overwhelm the **differences** resulting in the same retrieval cues being attached to both concepts.



# Lesson Design: Similarities

- List similarities and differences between subjects
- If the number of similarities is greater than differences, confusion is likely
- Teach a related concept to give the first concept time to be consolidated (12-14 hours)
- Teach the second similar concept later



# Lesson Design: Differences

- Start by teaching differences first
- Focusing on and practicing the differences gives learners the warnings and cues they need to identify them correctly in the future.



# Making it Stick

MAKING IT STICK

## Relationships

### Rigor

- Does not mean harder
- Effective use of questions
- Incorporation of symbols previously encountered
- Rule of Four: numerical, algebraic, tabular, graphical
- Build in ongoing scaffolding to support students' connections

### Relevance

- Makes connections within context of the problem
- Solving problems from prior course with new learning
- Relevance makes rigor possible, but relationships are key in determining relevance

# You are the scientist!



Your experience, with research and  
practice, is evidence of success in  
your classroom!



# Acknowledgements

- Dr. Robert Greenleaf, *Brain Based Teaching*, 2005
- Dr. George McCloskey, *Memory, Learning and Production*, 2007
- Dr. George McCloskey, *Executive Functions*, 2009
- David Sousa, *How the Brain Learns Mathematics*, 2008
- David Sousa, *How the Brain Learns*, 2001
- *Attributes of Digital Learners*, The 21<sup>st</sup> Century Fluency Project, [www.21stcenturyfluency.com](http://www.21stcenturyfluency.com)
- Patricia Wolfe, *Brain Matters*
- Education Week, 1/11/06, [www.schoolchange.org](http://www.schoolchange.org)
- "Layered Curriculum" is a registered trademark developed by and registered to Kathie F. Nunley. Additional information is available at <http://help4teachers.com>.
- David Eagleman, "Why Brain Science Matters to Educators", November 2012, VAIS