Brain-Based Learning in Mathematics

Pierce Convocation

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Your Brain

• Weighs about 3 pounds
• Is the size of a small grapefruit
• Makes up about 2% of your body weight, but
• Uses 20% of your calories
Exterior regions of the brain
The Frontal Lobe

• Controls planning, higher-order thinking, problem-solving and regulates excesses of the emotional system

• Continues to mature during adolescence and early adulthood

• Thus, adolescents are more prone to submit to their emotions
The limbic system
The Limbic System

• Oldest portion of the brain
• **Thalamus**: directs sensory information for processing
• **Hypothalamus**: monitors internal systems
• **Hippocampus**: converts information from working memory to long-term storage
• **Amygdala**: regulates emotions. Encodes an emotional message to long-term memories
How does the brain process information?

• In the 1960’s, a computer model was popular
• This model was associated with the “New Math”: input definitions and axioms, and the rest flows naturally
• Actually, the brain stores sequences of patterns scattered in various locations
Memories are dynamic; the brain changes with experience
Information Processing Model

• Sensory Register
• Immediate Memory
• Working Memory
• Long-term Storage
Sensory Register

The thalamus evaluates and filters sensory data for survival content
Immediate Memory

Holds data for about 30 seconds
Immediate Memory

• Sensory data move from the thalamus to the cortex
• The cortex assesses data for importance, according to the hierarchy:
  1. Data affecting survival
  2. Emotional data
  3. Data for new learning
• Emotions can enhance memory or block it entirely
Working Memory

The brain analyzes and builds ideas for eventual storage
Did you verbalize the digits to yourself?
Working Memory

• Can handle 5-9 items at a time
• Combining auditory and visual processing increases interaction between working and long-term memory
• Can process information for 10-20 minutes before fatigue sets in
• To continue processing, must switch to a different mode of study
Long-Term Storage

How is information in working memory transferred to long-term storage?
Criteria for Long-Term Storage

Two questions determine whether information is saved:

1. **Does this make sense?**
   Can the learner understand it on the basis of past experience

2. **Does it have meaning?**
   Is it relevant to the learner
• Of the two questions, meaning has the greater impact on the probability of storage

• Most teachers spend many hours on question (1), but not much time on question (2)
Long-term Storage: When

• Just because students seem to grasp new ideas does not mean they will be stored
• The greatest loss of new information occurs within 18-24 hours
• Long-term storage is a slow process and occurs during REM sleep
Long-term Storage: How

• **Rehearsal:** the repetition and processing of information, when the learner makes sense of material and assigns meaning and relevance.

• **Closure:** the process whereby working memory summarizes its perception of material. Rehearsal is completed and meaning attached to information.
Rehearsal

• There is almost no long-term retention without rehearsal.

• Time is a critical component

• Learners must establish connections in order to use information

• Combine massed practice for fast learning with distributed practice (practice over time) to promote retention
Closure

- Closure is not the same as review:
  - In review, the teacher does most of the work;
  - In closure, the student does the work by mentally rehearsing and summarizing concepts.
- Closure can be used at various times in a lesson
How can our knowledge of how the brain learns inform our lesson design?
Retention During a Learning Episode

- Prime-time-1
- Prime-time-2
- New Information
- Practice
down-time
- Closure

Degree of Retention

Time in Minutes: 0 to 40
Lesson Basics

• Begin with new material in prime-time-1
• Follow with practice or review during down-time
• Provide closure during prime-time-2
• The longer the lesson, the longer the down-time
• Break a lesson into segments, and go off-task for a break between segments
Retention by Teaching Method

- Lecture, 10%
- Reading, 15%
- Demonstration, 20%
- Discussion Group, 50%
- Practice by Doing, 75%
- Teach Others, 90%
No one teaching method is best – change it up!