Brain Matters: Translating Research to Classroom Practice

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How the Brain Works
The brain, our 3-pound universe!
Vascular System of the Brain
Brain imaging techniques allow us to see which areas of the brain control various functions.
Two Brains Playing a Computer Game

PET images depict levels of activity in the brains of two people playing a computer game. With red and yellow indicating high levels of activity, the scans reveal that an experienced player (below, right) burns significantly less energy than a novice (below, left). Learning, then, seems to be a function not of greater effort but of increased neuronal efficiency. Indeed, players who score high on standard IQ tests show the most precipitous drop in mental exertion while learning the game.
PET of Reading

Sources: Bookheimer et al, “Human Brain Mapping”
Neurogenesis

• During the 9 months of fetal development, neurons grow at the rate of 250,000 per minute

• At birth the brain has approximately 100 billion neurons

• At birth the brain weighs about 1 pound, at one year it has doubled and by age 5 or 6 it is 90% of its adult size and weight

• In the adult brain there are a quadrillion connections
What is Learning & Memory?

• Learning is the act of making (and strengthening) connections between thousands of neurons forming neural networks or maps.

• Memory is the ability to reconstruct or reactivate the *previously-made connections*.

• Neurons that fire together, wire together!
1. Experience sculpts the brain.

• Between the second month in utero and the age of two, each neuron in the cortex forms an average of 1.8 synapses per second.

• Which synapses remain, and which are pruned, depends on whether or not they carry any traffic. If not used, then like bus routes that attract no customers, they go out of business.
Growth of Connections

Neurons in cerebral cortex - Newborn

Neurons in cerebral cortex - 2-year-old
2. The brain seeks meaningful patterns.

- Our species has not survived by taking in meaningless information!
- Every encounter with something new requires the brain to fit the new information into an existing category or network of neurons.
- If it can’t find a connection, the information is dropped.
Attention

Since there is no way that the brain can pay conscious attention to all the sensory data that are constantly bombarding the body, it filters out information that is not relevant.

Approximately 99% of all information entering through the senses is immediately dropped.

When it comes to paying attention, the brain is much more like a sieve than a sponge!
Factors that Influence Attention

There are two factors that strongly influence whether or not the brain pays attention to incoming stimuli.

1. Whether or not the information has meaning, and

2. Whether or not the information has an emotional component or hook.
What do You See?
What do You See?
What do You See?
Using Analogy to Understand Large Numbers

• Draw a line approximately 4 inches long

• Label the left end of the line “one million dollars”

• Label the right end of the line “one trillion dollars”

• Make a mark on the line indicating where one billion dollars would fall
If the World Were a Village

If we could shrink the earth’s population to a village of precisely 100 people, with all the existing human ratios remaining the same, there would be:

* 61 Asians, 13 Africans, 12 Europeans, 8 South Americans (includes Central America and Mexico) 5 from the U.S. and Canada, and 1 from Oceania (Australia, New Zealand and the islands of the south, west and central Pacific.)

* 22 speak a Chinese dialect (18 of these Mandarin) 9 speak English, 8 speak Hindi, 7 speak Spanish, 4 speak Arabic, 4 speak Bengali, 3 speak Portuguese and 3 speak Russian.
If the World Were a Village
(continued)

* 76 people have electricity, 42 have a radio, 24 have televisions, 14 have a telephone and 7 persons have a computer.

* The villagers have 31 sheep and goats, 23 cows, bulls and oxen, 15 pigs, 3 camels, 2 horses and 189 chickens....yet 60 people are always hungry and 26 are severely undernourished. Only 24 always have enough to eat.

* Of the 88 people old enough to read, 71 can read a little but 17 cannot read at all.

From “If the World Were a Village” by David Smith, Kids Can Press, 2002
3. Emotions are a primary catalyst in the learning process.

- Emotion can play either a negative or a positive role in the learning process.

- If a student perceives a situation to be threatening, the thinking part of the brain shuts down and learning is impeded.

- However, if the emotion generated by a learning experience is pleasant, learning is enhanced.
Understanding Emotion

Emotional arousal occurs when a small set of structures in the unconscious part of the brain determines that a stimulus is important.

The arousal sets off a chain of chemical changes in the body and the brain that have a strong impact on attention and memory.
Emotion in the Classroom

Emotion is a double-edged sword. At times it can impede learning.

Surviving is not just something to do in the presence of a wild beast. Social and learning situations are often survival encounters.

When the brain perceives a situation to be threatening, the stress (fight-or-flight) response is activated.
Emotion’s Positive Role

While emotion sometimes impedes learning, it can also play an important role in the enhancement of learning.

Adrenalin not only activates the stress response, it also stamps with extra vividness the memory for that event.

Anything you do which engages students’ emotional/motivational interest will naturally engage the adrenalin system and result in stronger memories.
4. There are two distinct types of memory.

• Procedural Memory

Skills and habits that have been practiced to the point where they are automatic and unconscious.

• Declarative Memory

Our general knowledge and our life experiences that we can declare or recall consciously.
Rehearsal Strategies to Match the Two Types of Memory

• **Rote Rehearsal** works best for Procedural Memory
  – Much repetition is needed

• **Elaborative rehearsal** works best for Declarative Memory
  – Reciprocal or peer teaching
  – Metaphor and analogy
  – Problem-based learning
  – Visuals and graphics
  – Simulations
  – Hands-on activities
  – Rhythm, rhyme and rap